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**DAVID W. TAYLOR NAVAL SHIP
RESEARCH AND DEVELOPMENT CENTER**

Bethesda, Maryland 20084

THE PREDICTION OF RESISTANCE CHANGE
USING SMALL MODELS

by

Steven C. Fisher

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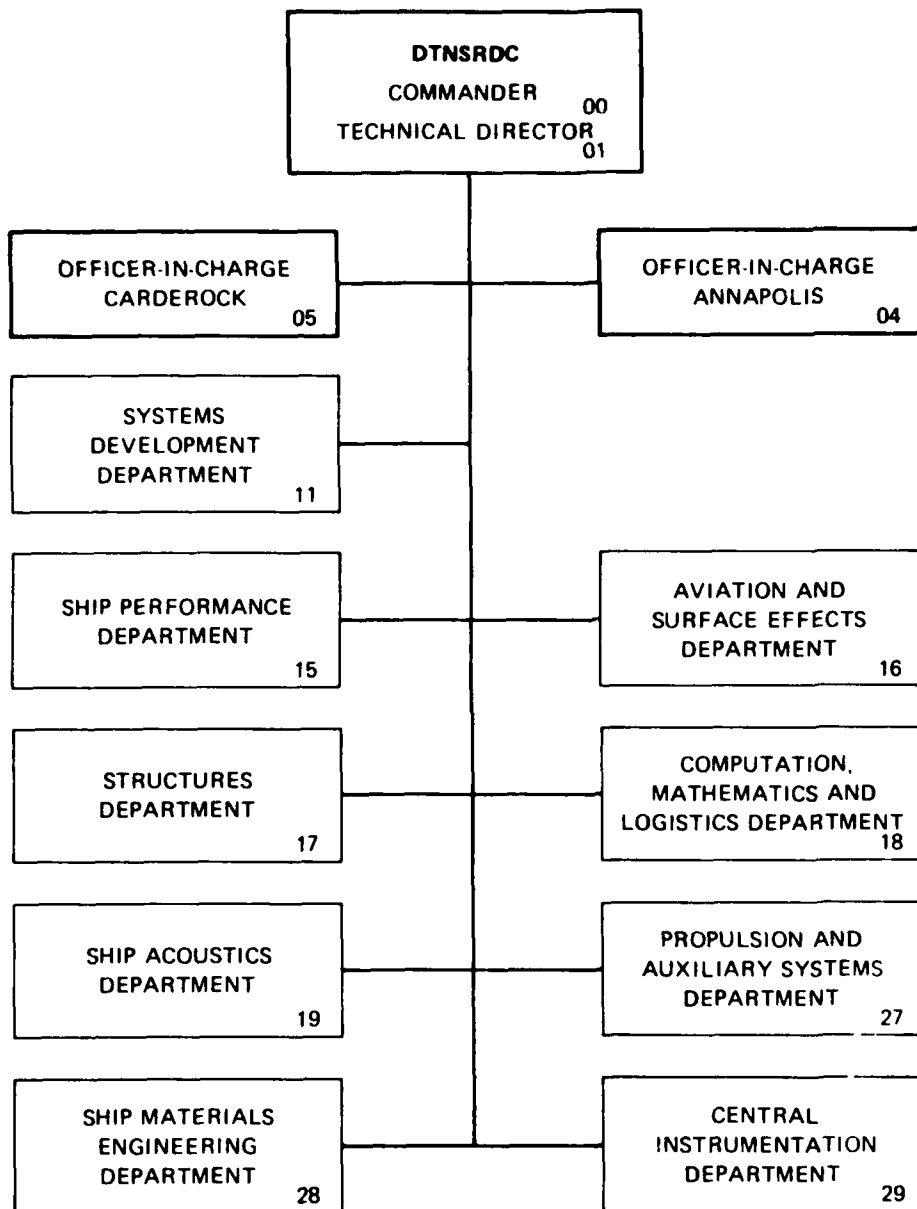
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obtain a comparison with the small model results at DTNSRDC. The results show that the small model resistance trends compare well with the large model resistance trends. The resistance of the small CVV-B model was found to be within one percent of the corresponding results from DL/SIT.

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NOMENCLATURE

		Units*
C_A	Correlation allowance	-
C_F	Frictional resistance coefficient, $R_F / \frac{1}{2} \rho S V^2$	-
C_R	Residuary resistance coefficient, $R_R / \frac{1}{2} \rho S V^2$	-
C_{SD}	Stud drag coefficient, $R_{SD} / \frac{1}{2} \rho S V^2$	-
C_T	Total resistance coefficient, $R_T / \frac{1}{2} \rho S V^2$	-
ΔC_{TM}	Difference in the total resistance coefficient between models with and without studs	-
F_n	Froude number	-
$1+k$	Hughes form factor	-
L	Length	L
R_F	Frictional resistance	ML/T ²
R_R	Residuary resistance	ML/T ²
R_{SD}	Stud drag	ML/T ²
R_T	Total resistance	ML/T ²
S	Wetted surface	L ²
V	Speed	L/T
ρ	Water density	M/L ³

ABBREVIATIONS

DL/SIT	Davidson Laboratory of the Stevens Institute of Technology
DTNSRDC	David Taylor Naval Ship Research and Development Center
SCS	Sea Control Ship
USNA	United States Naval Academy

*L = length, T = time, M = mass

SUBSCRIPTS

M	Model
S	Ship

ENGLISH/SI EQUIVALENTS

1 degree (angle)	= 0.01745 rad (radians)
1 foot	= 0.3048 m (meters)
1 foot per second	= 0.3048 m/sec (meters per second)
1 inch	= 25.40 mm (millimeters)
1 knot	= 0.5144 m/s (meters per second)
1 lb (force)	= 4.448 N (Newtons)
1 lb (force) - inch	= 0.1130 N m (Newton-meter)
1 long ton (240)	= 1.016 metric tons, or 1016 kilograms
1 horsepower	= 0.746 kW (kilowatts)

ABSTRACT

A series of resistance experiments were performed at the David Taylor Naval Ship R&D Center (DTNSRDC) to determine if the trends in resistance of a group of small models having somewhat similar hull forms compare well with the trends in resistance of a group of large model geosyms. Three variants of the CVV aircraft carrier were selected for these experiments; the large models represented a scale ratio of 31.435 (8.34 m), and the small models represented a scale ratio of 144 (1.82 m). One of the small models, CVV-B, was evaluated experimentally at Davidson Laboratory of the Stevens Institute of Technology (DL/SIT) to obtain a comparison with the small model results at DTNSRDC. The results show that the small model resistance trends compare well with the large model resistance trends. The resistance of the small CVV-B model was found to be within one percent of the corresponding results from DL/SIT.

ADMINISTRATIVE INFORMATION

This Project was authorized and funded by the Office of Naval Technology Ships, Subs, and Boats Exploratory Development Program under the management of NAVSEA 03R under Program Element 62543N, Task Area 421-252, Work Unit Number 1-1506-102-61.

INTRODUCTION

An experimental investigation was undertaken at DTNSRDC to determine if the trend in resistance change, due to small changes in hull shape, could be predicted correctly with the use of small size surface ship models.

Large models, sometimes more than 9.1 m (30 ft) in length, are in standard use at DTNSRDC for ship model experiments. The model hull size is determined from propulsion experiment requirements. It is our experience that model propellers smaller than 0.2 m (8 in.) in diameter are inadequate to model full scale flow conditions. The effect of Reynolds Number is too severe, preventing accurate full scale powering prediction. Thus, the hull model is built to a scale ratio that results in a model propeller diameter larger than 0.2 m (8 in). The resulting model lengths vary from 5.5 m (18 ft) to over 9.1 m (30 ft).

¹References are listed on page 13.

These hull models are also used for resistance experiments.

Having a large model for resistance experiments has the advantage of obtaining a more accurate geosym of the full scale hull than with a smaller model, with a given manufacturing tolerance, and the difficult problem of stimulating turbulence on the model is also mitigated. The use of large models however, to investigate the effect of minor changes in hull form on hull resistance is not practical in terms of time and cost.

The need to provide experimental information on the trend of change in resistance due to changes in hull shape during the design of a new class of surface ship often arises. The use of small models in exploring the resistance trends with changes in hull form would provide a solution. The investigation described herein is aimed at exploring the potential use of small models in a small towing tank for the purpose of predicting resistance trends with small changes in hull geometry.

Small ship models are used by several ship model basins for resistance experiments such as the Davidson Laboratory of the Stevens Institute of Technology (DL/SIT) and the United States Naval Academy (USNA).

The experience of DL/SIT is adopted in this investigation to explore the trends in resistance of small models versus large models. The interest here is not in absolute values obtained, but in trends due to changes in hull form. The historical data base at DTNSRDC, used in the prediction of full scale resistance of ship hulls, which includes model-full scale correlations, was established for large models. Thus, it is not the purpose of this investigation to establish a (new) small model-to ship correlation, but to investigate the possibility of using small models to predict trends in resistance. The trends in the change in small model resistance will be compared with those of standard (large size) models.

The CVV aircraft carrier hull form variants were selected for this project because three 8.34 m (27.36 ft) long CVV models were available from previous projects. Three 1.82 m (5.97 foot) geosyms of the 8.34 m models were built to represent the small models. The three CVV hulls are designated as CVV-A, CVV-B, and CVV-D.

One of the small models, CVV-B, was built and its resistance performance evaluated experimentally at DL/SIT. This allowed us to compare our results of the small CVV-B model to the results of the same model from a model basin with an extensive background in small model experimentation.

The small bare-hull model experiments were performed in the 140 Foot Basin at DTNSRDC, and the large bare-hull model experiments were performed in the Deep Water Basin at DTNSRDC. Previous resistance experiments with the large models were performed with the models fully appended; no previous bare hull resistance data existed. An additional series of experiments with the small models were performed in the Deep Water Basin to verify the small model resistance results from the 140 Foot Basin experiments. However, because of problems with the small model towing system in the Deep Water Basin, the results are not included in the main body of this report, but are presented in Appendix A.

The small model experiments were performed using the techniques used by DL/SIT with the small CVV-B model. This included the method used for turbulence stimulation, i.e., stud size, location and spacing and the stud drag correction method.

The results of the resistance experiments and comparisons of the trends in resistance between the large and small models are presented in this report. The resistance performance of the small CVV-B model from the experiments performed at DTNSRDC are compared with the results from DL/SIT. The full scale effective

power predictions based on the small model results are compared with the large model effective power predictions.

EXPERIMENTS

MODELS

The small models, 5385, 5386, and 5387, represent the three CVV design variants CVV-A, CVV-B, and CVV-D, respectively. These three models are constructed of wood to a scale ratio of 144, resulting in a model length of 1.82 m (5.97 ft). Models 5385 and 5387 were built at DTNSRDC; Model 5386 was built at DL/SIT. The models have no appendages except for the skeg.

The large models, 5368, 5372, and 5382, also represent the three CVV design variants CVV-A, CVV-B, and CVV-D, respectively. These three models are constructed of wood to a scale ratio of 31.435, resulting in a model length of 8.34 m (27.36 ft). All of the appendages, except for the skeg, were removed before the experiments.

The principal dimensions of the ships and models are given in Table 1. The CVV-A models were ballasted to represent a full scale displacement of 63430 t (62430 L. tons), and an even keel draft of 10.36 m (34.0 ft); the CVV-B models were ballasted to represent a full scale displacement of 63430 t (62430 L. tons) and an even keel draft of 10.36 m (34.0 ft); and the CVV-D models were ballasted to represent a full scale displacement of 62970 t (61980 L. tons) and an even keel draft of 10.55 m (34.6 ft).

The small models were towed using the planing boat towing bracket on loan from the USNA model basin. This bracket attaches to the model at one point, and fixes the model in sway, yaw, and roll. The drag measurements were taken with a 5 pound block gauge. Figure 1 shows a photograph of the tow bracket and block gauge fitted in a model.

In the 140 Foot Basin, the small models were connected to the carriage by a braced vertical strut. A number of experiments were performed to improve the strut bracing system and the number and location of rubber blocks to dampen vibration. The improvements were judged by the size of the noise reduction in the drag signal. The noise in the drag signal was reduced by a factor of three with the final bracing system from that obtained with the initial set-up.

TURBULENCE STIMULATION

Turbulence stimulation was required on the small models to obtain turbulent flow over the hull. Studs were selected for turbulence stimulation because DL/SIT has indicated that, when studs were used for turbulence stimulation, the resistance data were more consistent than when either struts or sand strips were used. Also, the DL/SIT resistance experiments with the small CVV-B model were performed using studs for turbulence stimulation. The stud size, spacing, and longitudinal location used with the small models were based on those used by DL/SIT with the CVV-B model. The studs, 3.2 mm (0.125 in.) dia by 2.5 mm (0.10 in.) high, were spaced 6.4 mm (0.25 in.) apart, and 15 mm (0.6 in.) aft of, and parallel to, the stem. The longitudinal location was selected using a method by Hughes¹, which uses the entrance half angle to determine the stud longitudinal location.

The studs not only induce turbulence, but also add a drag component to the total measured resistance. This stud parasitic drag component must be subtracted out from the measured resistance to obtain the resistance of the hull alone. The method of stud parasitic drag correction used by DL/SIT in the analysis of the small CVV-B model assumes that, at higher speeds, the model without studs has turbulent flow over the entire hull (except in the immediate area of the stem)

so that turbulence stimulation is unnecessary. Therefore, the difference in resistance between the model with and without studs at the high speeds is the stud parasitic drag.

No turbulence stimulation was used with the large models because it is not considered necessary with large models; also, none was used in previous experiments with the large models.

EXPERIMENTAL PROCEDURE

The large and small CVV models were evaluated over a speed range corresponding to 5.1 m/s to 15.4 m/s (10 knots to 30 knots), full scale, or $F_n = 0.10$ to 0.30. The resistance values were measured using a block gauge. The large model resistance data was sampled over a period of 5 seconds. The small model resistance data from the 140 Foot Basin was sampled over a period ranging from 7 to 24 seconds; the longer sampling periods correspond to lower model speeds.

PRESENTATION OF RESULTS

The measured and faired resistance values for the large and small CVV models are shown in Figures 2 to 12, and the measured resistance values are shown in Tables 2 to 12. The resistance values for the small CVV-B model from the experiments at DL/SIT are also included. The resistance curves are faired indirectly by fairing the residuary resistance coefficient (C_R) values, shown in Figures 13 to 19. The C_R values are calculated from the total resistance, R_{TM} , using the ITTC correlation line.

At the low Froude numbers, there is noticeable scatter in the small model C_R values, especially when the models are not fitted with studs. Because the models without studs do not have turbulence stimulation, the location of the transition point at which the flow over the hull changes from laminar to

turbulent may vary even though the speed is held constant. Since the frictional resistance with laminar flow is significantly lower than that for turbulent flow, a change in the location of the flow transition may result in a noticeable change in the total resistance. The negative C_R values for the unstimulated models are a result of the C_R values calculated using the ITTC model-ship correlation line, which assumes that the flow over the hull is turbulent; however, because of the amount of laminar flow which existed over part of the hull, the actual frictional resistance was lower than that given by the ITTC model-ship correlation line. Thus, the negative values of C_R appearing in Figures 13 through 19 have no physical significance. It should be noted that, because the resistance data for the models without studs are used only to determine the stud drag correction, which uses only the resistance data at higher speeds, the C_R scatter and negative C_R values at the lower speeds for the models without studs do not effect the model resistance results. The C_R scatter and negative C_R values for the models with studs may be due to insufficient turbulence stimulation at very low speeds. Another reason for the scatter is that the resistance values measured are extremely small, and might not be resolved with sufficient accuracy at the lower speeds.

To assist in the low speed C_R fairing, a method presented by Prohaska² is used. The data, replotted as C_{TM}/C_{FM} versus F_n^4/C_{FM} , are shown in Figures 20 to 26. Prohaska states that over the range of $F_n = 0.1$ to $F_n = 0.2$, a curve fitted to these points is a relatively straight line for most models. Because of the way the low speed data are compressed, it is much simpler to fair the Prohaska plots than to fair the C_R plots; therefore, the results from faired Prohaska curves are used to assist in fairing the C_R curves. The C_{FM} values are from the ITTC model-ship correlation line.

An additional benefit of using the Prohaska plots is that the form factor $(1+k)$ value used in the Hughes³ method of model-ship extrapolation is easily obtained. The C_{TM}/C_{FM} value at the intersection of the faired curve with $F_n^4/C_{FM} = 0.0$ is equal to the form factor, $1+k$.

Curves of total resistance coefficient (C_{TM}) versus Froude number for the small models are shown in Figures 27 to 30. The curves of the difference between the C_{TM} curves of the small models with and without studs, ΔC_{TM} , are also presented in these graphs.

The stud drag coefficient, C_{SD} , is considered to be constant with speed, and is calculated by averaging the ΔC_{TM} curves at the high Froude number range, where the difference in resistance between the models fitted with and without studs are considered to be only due to the drag of the studs. DL/SIT averaged the ΔC_{TM} curve above $F_n = 0.2$ for the small CVV-B model; however, since the ΔC_{TM} values are not relatively constant until the higher Froude numbers are reached, in the present work the ΔC_{TM} curves are averaged above Froude number $F_n=0.28$, depending upon the shape of the ΔC_{TM} curve.

Figure 31 shows the ratio of R_{TM} (DL/SIT) to R_{TM} (140 Foot Basin) versus Froude number for the small CVV-B model fitted with studs.

To show the relative resistance performance of the models, the full scale predicted resistance curves were normalized by the average of the full scale predicted resistance of the models. The average resistance, $R_{TS}(AVE)$ is defined as:

$$R_{TS}(AVE) = (R_{TS}(CVV-A) + R_{TS}(CVV-B) + R_{TS}(CVV-D))/3.$$

The large model full scale resistance curves were normalized by the average full scale resistance for the large models, and the small model full scale resistance

curves were normalized by the average full scale resistance for the small models. These curves of R_{TS}/R_{TS} (AVE) are shown in Figures 32 and 33 for correlation allowance $C_A = 0.0005$ and 0.00035 for the small models, and 0.00035 for the large models. Changing the small model C_A value from 0.00035 to 0.0005 changed the relative resistance performances very little; the maximum change was $1/2$ percent. Since changing the C_A value has a small effect on the relative resistance performances, and a small model C_A value of 0.0005 gave the best correlation between the large and small model full scale resistance predictions, a small model C_A value of 0.0005 will be used unless otherwise noted.

The R_{TS}/R_{TS} (AVE) curves for the CVV hull forms based on the Taylor Standard Series data are presented in Figure 34.

The predicted relative resistance performances of CVV-A, CVV-B, and CVV-D are shown in Figures 35 to 37, respectively. The large model, small model, and Taylor Standard Series R_{TS}/R_{TS} (AVE) predictions are plotted together.

Figures 38 to 40 show relative comparisons of the small model full scale predictions to the large model full scale predictions, presented as R_{TS} (small model)/ R_{TS} (large model), versus Froude number. The model scale data are extrapolated using the ITTC model-ship correlation line with a large model C_A value of 3.5×10^{-4} . The small model data are extrapolated using both the Froude and Hughes method of extrapolation. The Hughes method assumes that

$$C_{TS} = C_R + (1+k)C_{FS} + C_A,$$

$$\text{where } C_R = C_{TM} - (1+k)C_{FM}.$$

A series of experiments were performed to obtain some measure of repeatability in the small model resistance data. The small models were tested at three

different speeds, repeating the speeds six times in a random pattern. The speeds corresponded to $F_n = 0.18, 0.24, \text{ and } 0.28$. The results are shown in Table 13, and are given in terms of maximum difference in the resistance values over the mean resistance value.

DISCUSSION OF RESULTS

Since the small CVV-B model was evaluated experimentally at both DTNSRDC and DL/SIT, the resistance results can be compared directly to determine if the experimental techniques and equipment used with the small models gave reasonable results. The faired curve of the DL/SIT resistance data, normalized by the faired R_{TM} data from DTNSRDC is shown in Figure 31. The maximum difference between the DTNSRDC and the DL/SIT resistance values is 1 percent; therefore, the DL/SIT results have been repeated very well.

The relative resistance $R_{TS}/R_{TS}(AVE)$ values for the large and small CVV-A models show excellent correlation: less than 1 1/2 percent difference between the relative resistance values above a Froude number of 0.16. The relative resistance values for the large and small CVV-B models have less than 1 percent difference below a Froude number of 0.24 and above a Froude number of 0.28; between $F_n = 0.24$ and 0.28 the difference increases to 3 percent. The relative resistance values for the large and small CVV-D models have less than 2 percent difference. Therefore, the relative resistance performances of the small CVV models compare well to the relative resistance performances of the large CVV models.

The relative resistances of the CVV hull forms were also predicted using a Taylor Standard Series approximation. The $R_{TS}/R_{TS}(AVE)$ curves based on the Taylor Standard Series predictions have no similarity with the large model relative resistance curves except at the highest speeds. Therefore, for these CVV hull

forms, the small models were far more effective in predicting the change in resistance due to changes in the hull form than the Taylor Standard Series. It should be noted that the accuracy of the Taylor standard series predictions may improve with significantly different hull form shapes.

The small model resistance data are extrapolated to full scale and can be compared with the large model predictions as seen in Figures 38 to 40. The small model Froude method resistance predictions with the same C_A value as the large models, ($C_A = 3.5 \times 10^{-4}$) are lower than the large model predictions by as much as 9 percent. If the C_A value used with the small model predictions is increased to 5.0×10^{-4} to minimize the average difference, then the differences between the large and small model predictions are within ± 4 percent. The higher C_A value for the small models seems reasonable; small models have greater scale effects than large models. The small model Hughes method resistance predictions need an even larger C_A value, 6.0×10^{-4} , to minimize the difference between the large and small model predictions. The small model resistance predictions are higher than the large model predictions at lower speeds, and lower at the high speeds.

It should be noted that the small model C_A value was increased based on the comparison of the large and small model predictions. With a significantly different hull form, the small model C_A value could be quite different relative to the large model C_A value. The C_A values used with the large models were developed through comparisons of model predictions to ship trial data, accumulated over a long period of time. Similar efforts would be required for accurate determination of the appropriate C_A values to be used in small model resistance extrapolation. Also, even with an "adjusted" C_A value for the small models, the small model predictions differed from the large model predictions by ± 4 percent. It appears that the method in use at DTNSRDC to predict full scale resistance from large

model data is not appropriate to use with the small CVV model data for the prediction of full scale resistance. Because of the small sample (only three small models were tested), no general conclusions may be drawn with respect to the use of small models for resistance prediction.

The results from the small model repeatability experiments in Table 13 show that the maximum difference in the resistance values was 3.5 percent. A similar experiment, performed at DL/SIT with a 1.86 m (6.1 foot) SCS model (Model 5384) showed a maximum difference in the resistance values of 4 percent. Based on this comparison, the repeatability obtained at DTNSRDC seems reasonable.

CONCLUSIONS

1. The relative resistance performance of the small CVV models compare well with that of the large CVV models, and, gives significantly better resolution than Taylor Standard Series for the CVV hull forms evaluated.
2. For the extrapolation of resistance data to full scale, the small CVV models needed a larger correlation allowance than the large models for comparable full scale predictions. The appropriate small model C_A value could not be selected without the availability of large model data. Even with the aid of large model data, the small CVV model predictions were only within ± 4 percent of the large model predictions. Thus, using the same method for full scale prediction, the small model data provides different results than the large model data for the CVV models reported here. Because of the small sample (three models) general conclusions can not be drawn.
3. The resistance results with the small CVV-B model repeated the DL/SIT results.
4. The repeatability of the small model data obtained at DTNSRDC was compatible with that obtained at DL/SIT.

RECOMMENDATIONS

1. The proper role of the use of small models in the ship design process should be explored.
2. The 140 Foot Basin should be updated for small model testing. The improvements should include the update of both mechanical and electrical/electronic equipment.

ACKNOWLEDGEMENTS

The author wishes to thank Mr. John Hoyt of the United States Naval Academy for his invaluable aid during this project.

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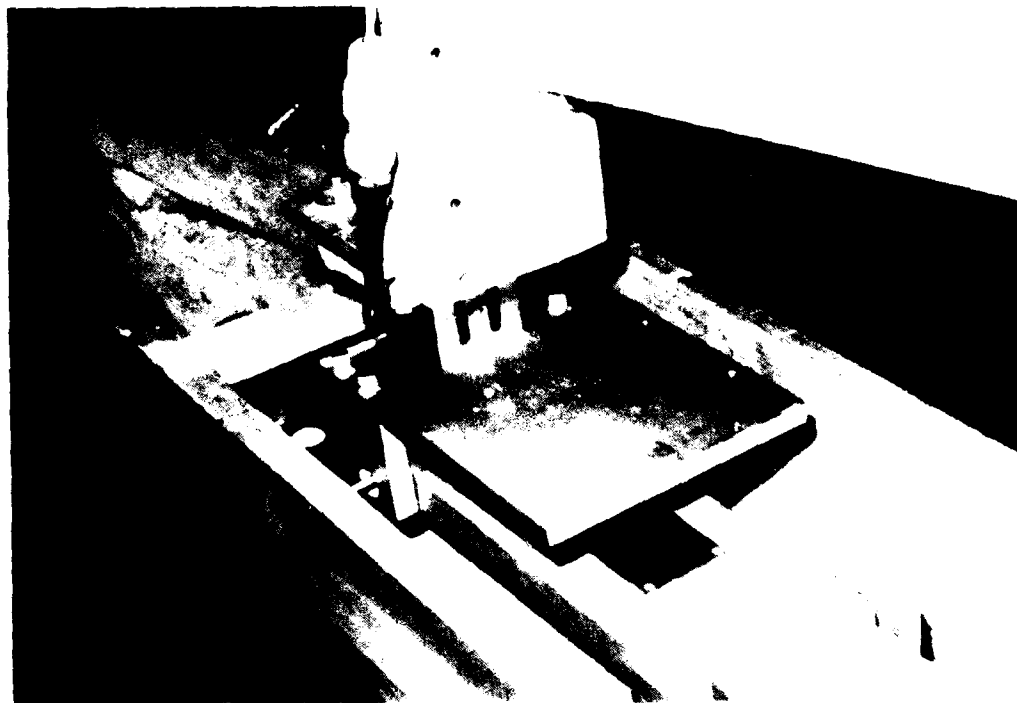
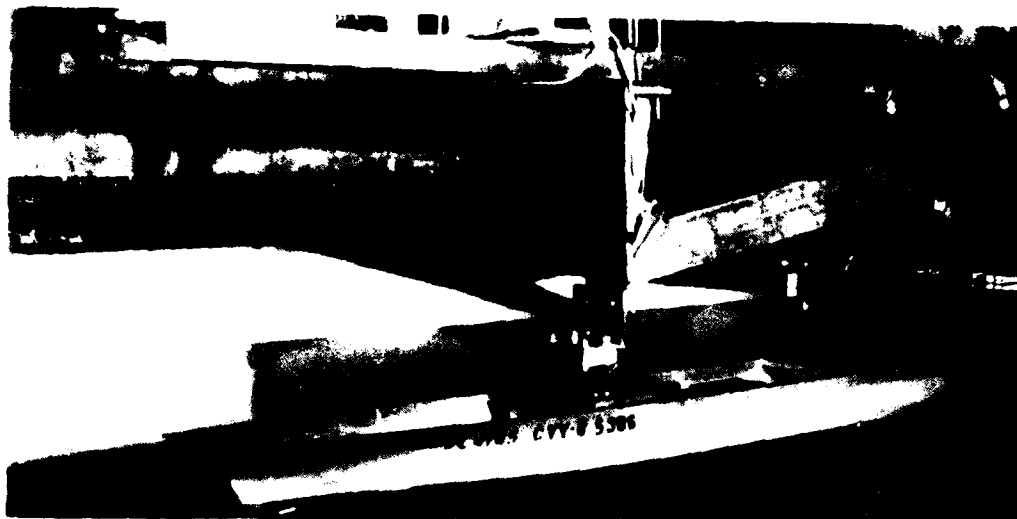


FIGURE 1 - SMALL MODEL TOWING ARRANGEMENT IN THE 1.0 FOOT BASIN

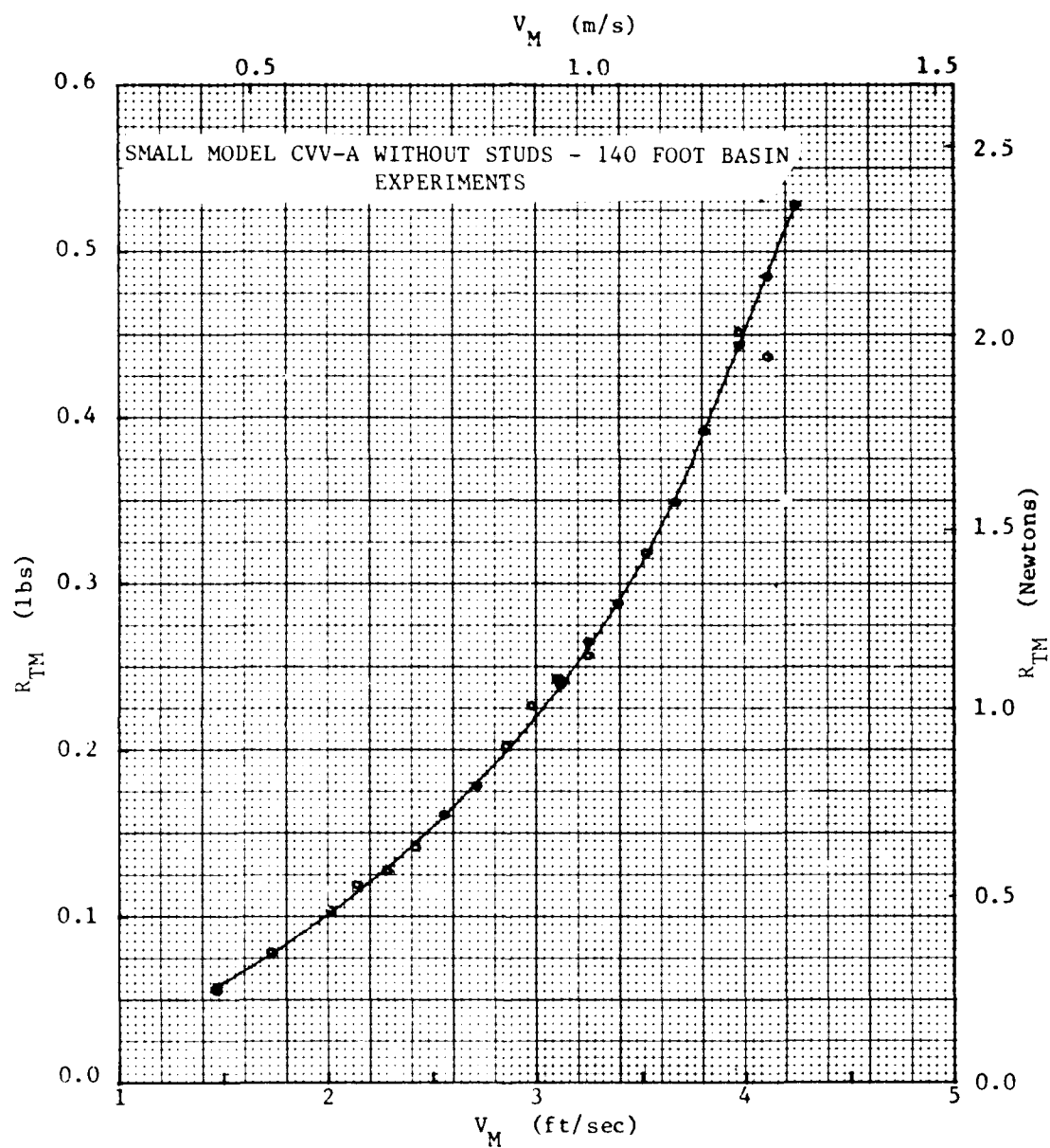


FIGURE 2 - RESISTANCE VALUES FOR THE SMALL CVV-A MODEL WITHOUT STUDS
FROM THE 140 FOOT BASIN EXPERIMENTS

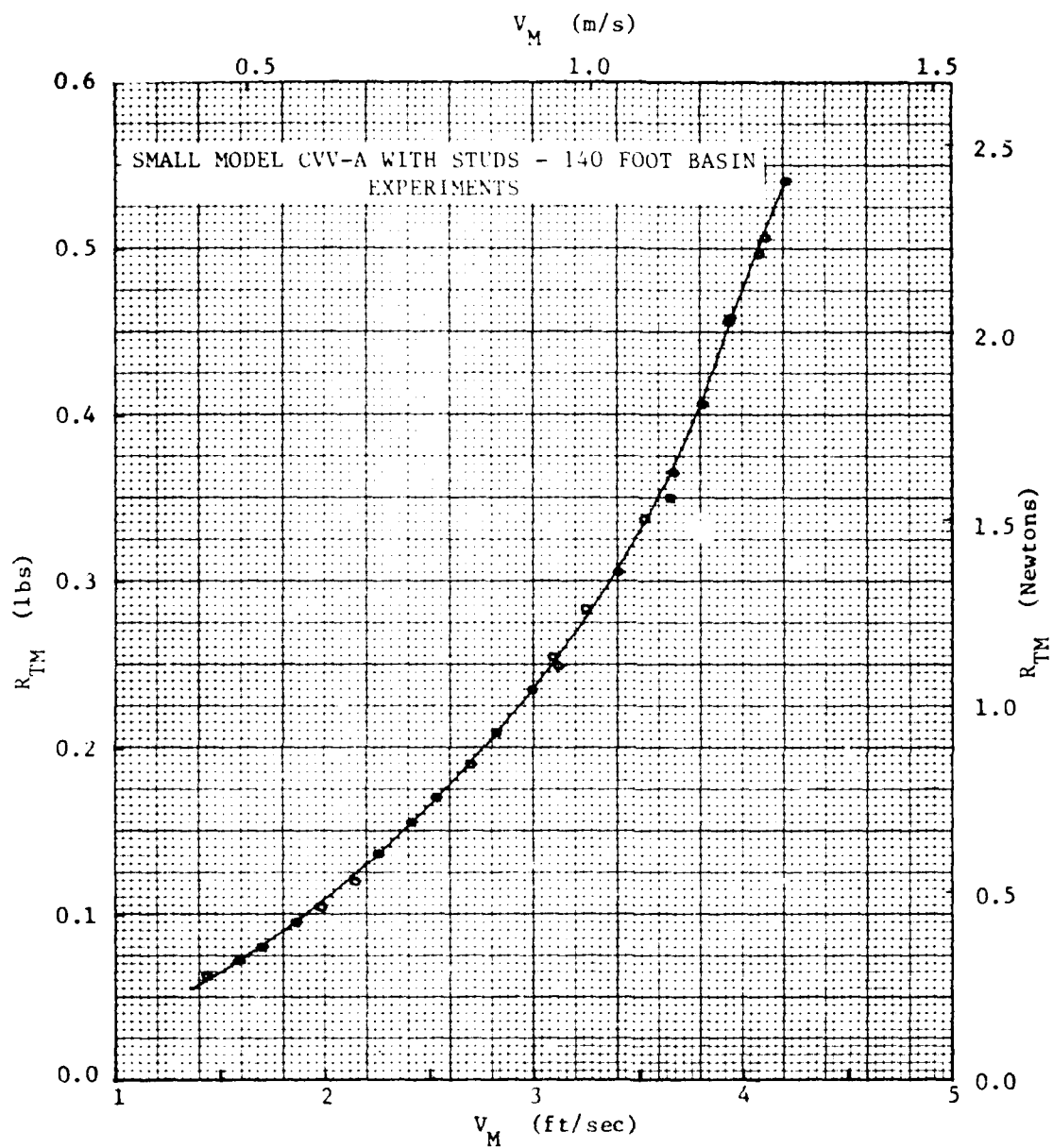


FIGURE 3 - RESISTANCE VALUES FOR THE SMALL CVV-A MODEL WITH STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

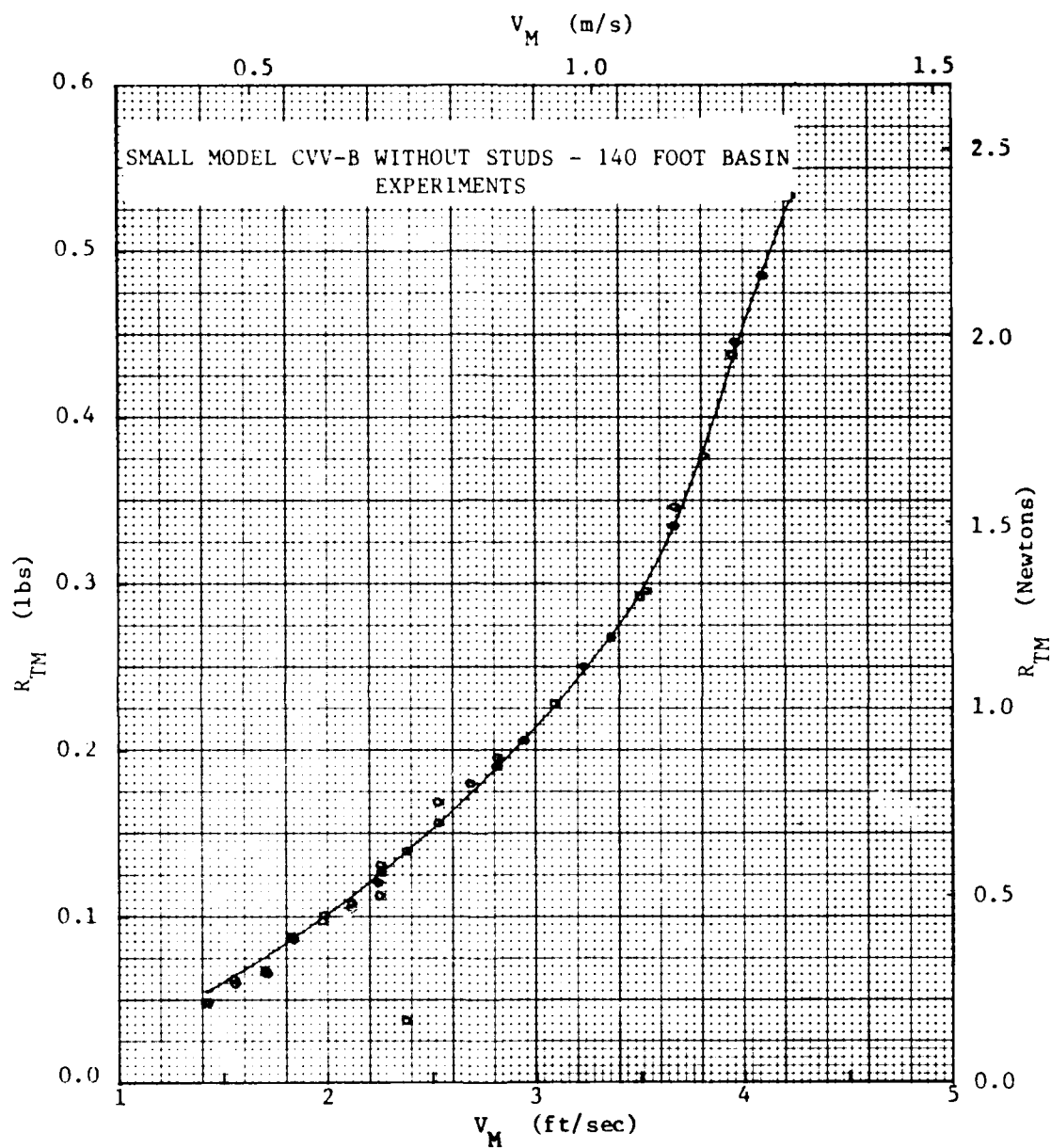


FIGURE 4 - RESISTANCE VALUES FOR THE SMALL CVV-B MODEL WITHOUT STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

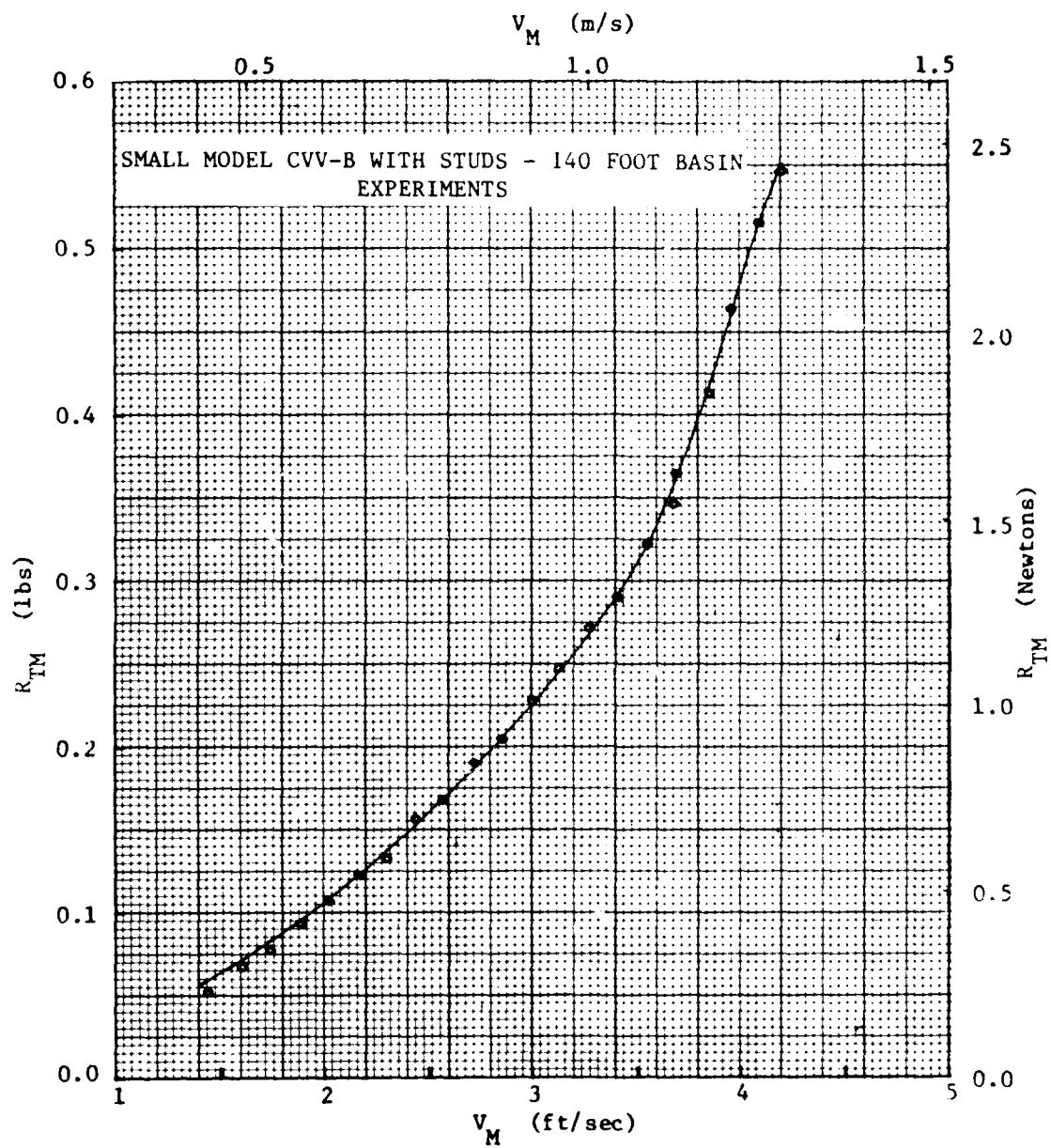


FIGURE 5 - RESISTANCE VALUES FOR THE SMALL CVV-B MODEL WITH STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

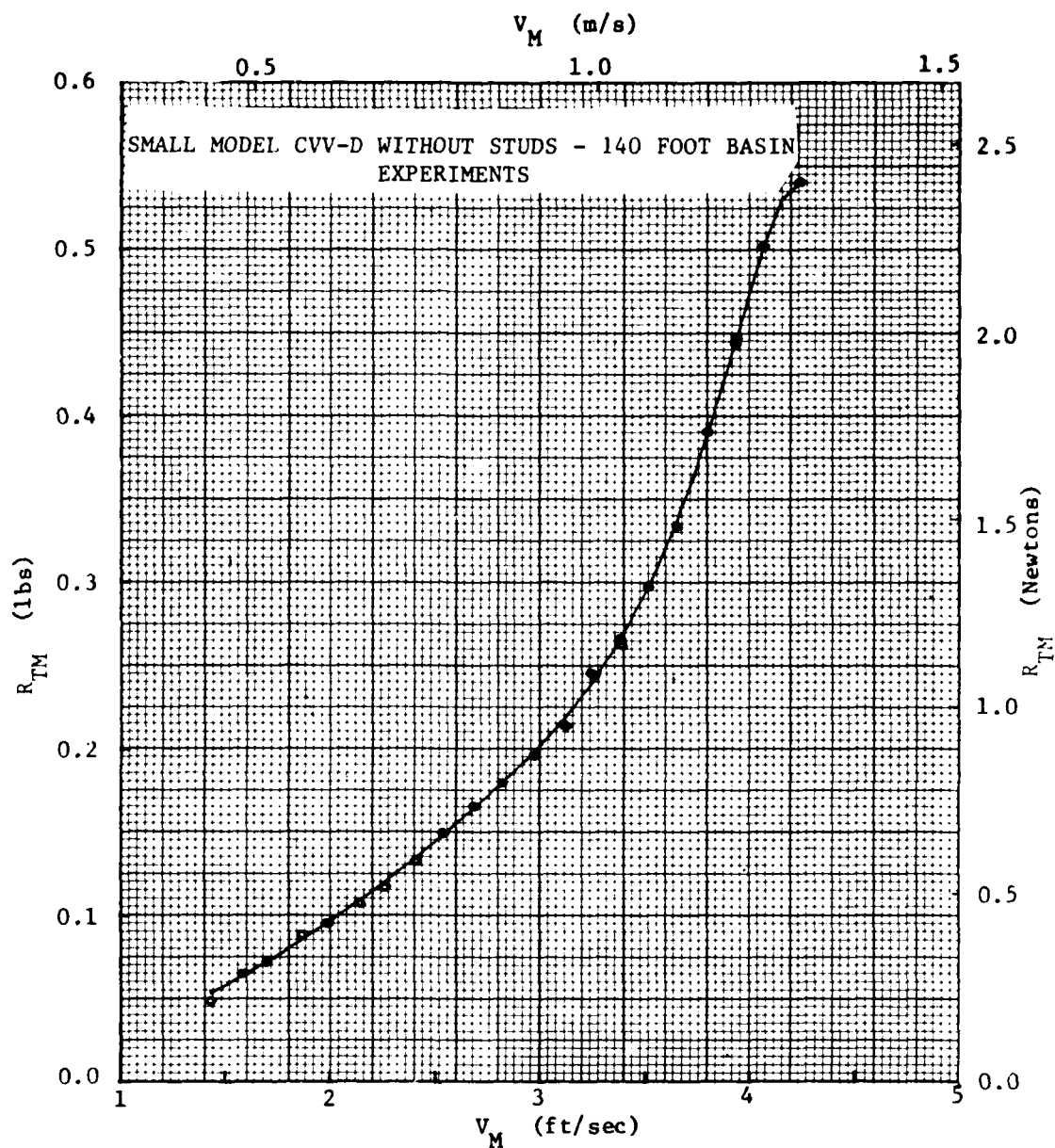


FIGURE 6 - RESISTANCE VALUES FOR THE SMALL CVV-D MODEL WITHOUT STUDS
FROM THE 140 FOOT BASIN EXPERIMENTS

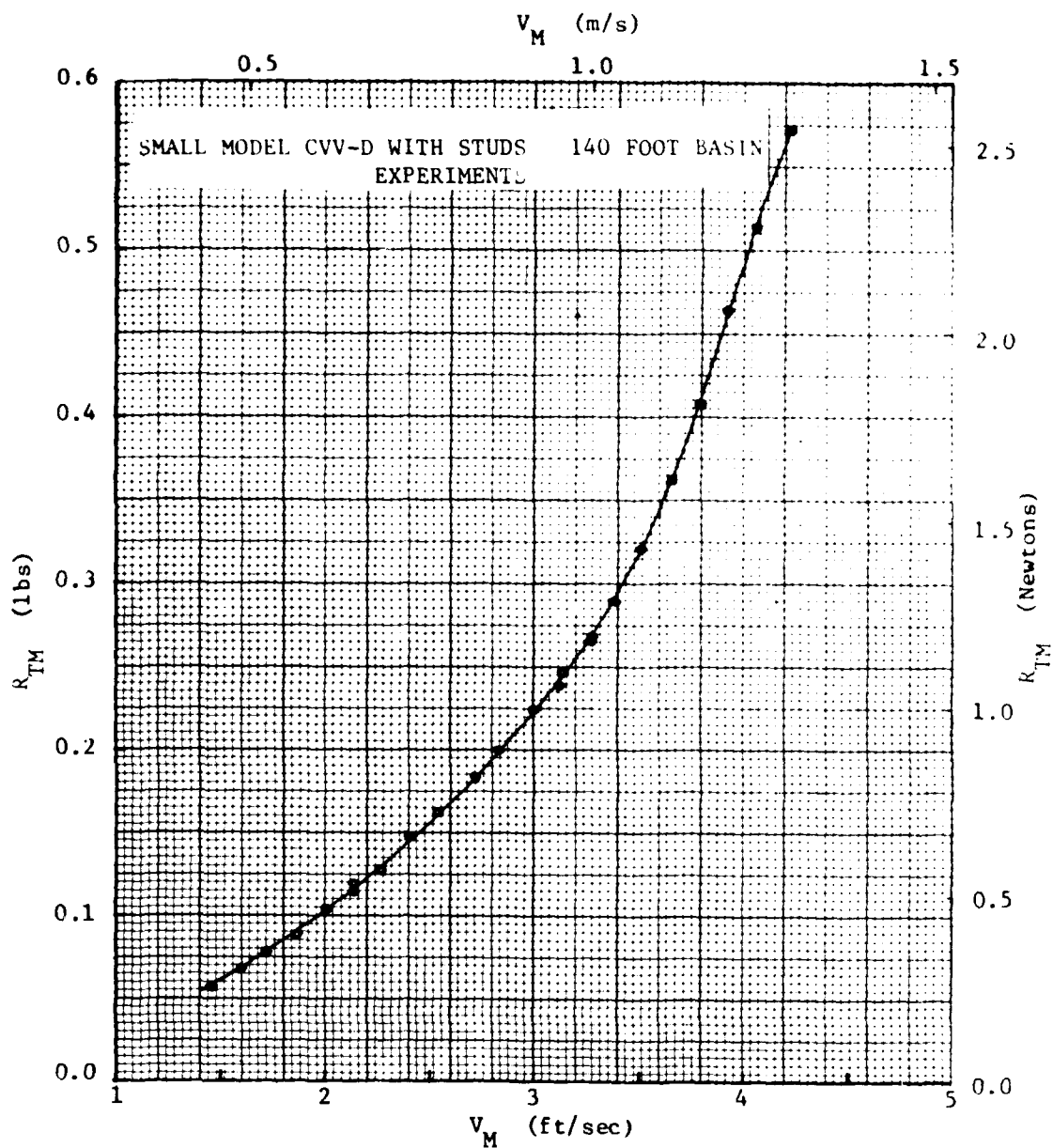


FIGURE 7 - RESISTANCE VALUES FOR THE SMALL CVV-D MODEL WITH STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

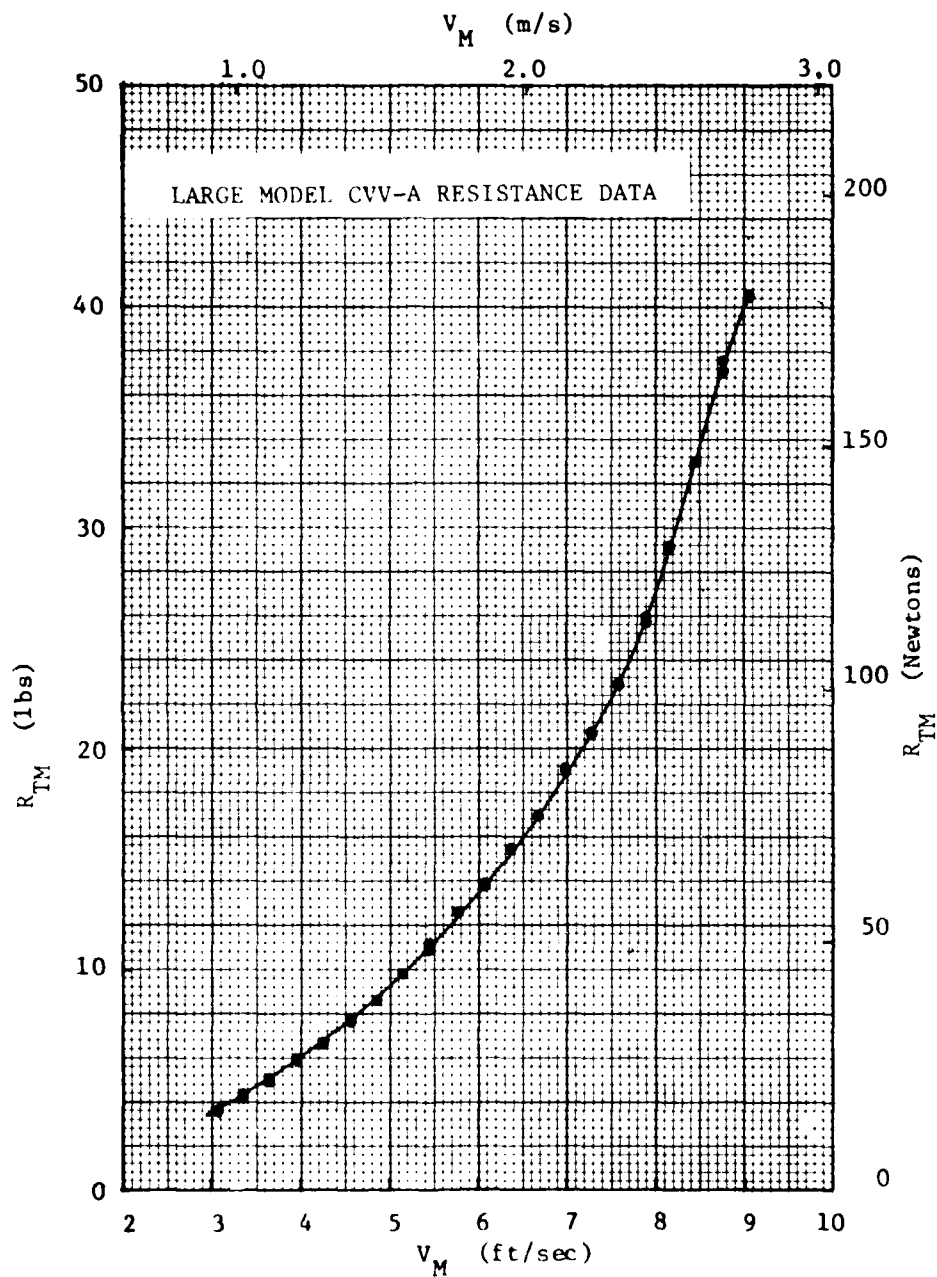


FIGURE 8 - RESISTANCE VALUES FOR THE LARGE CVV-A MODEL

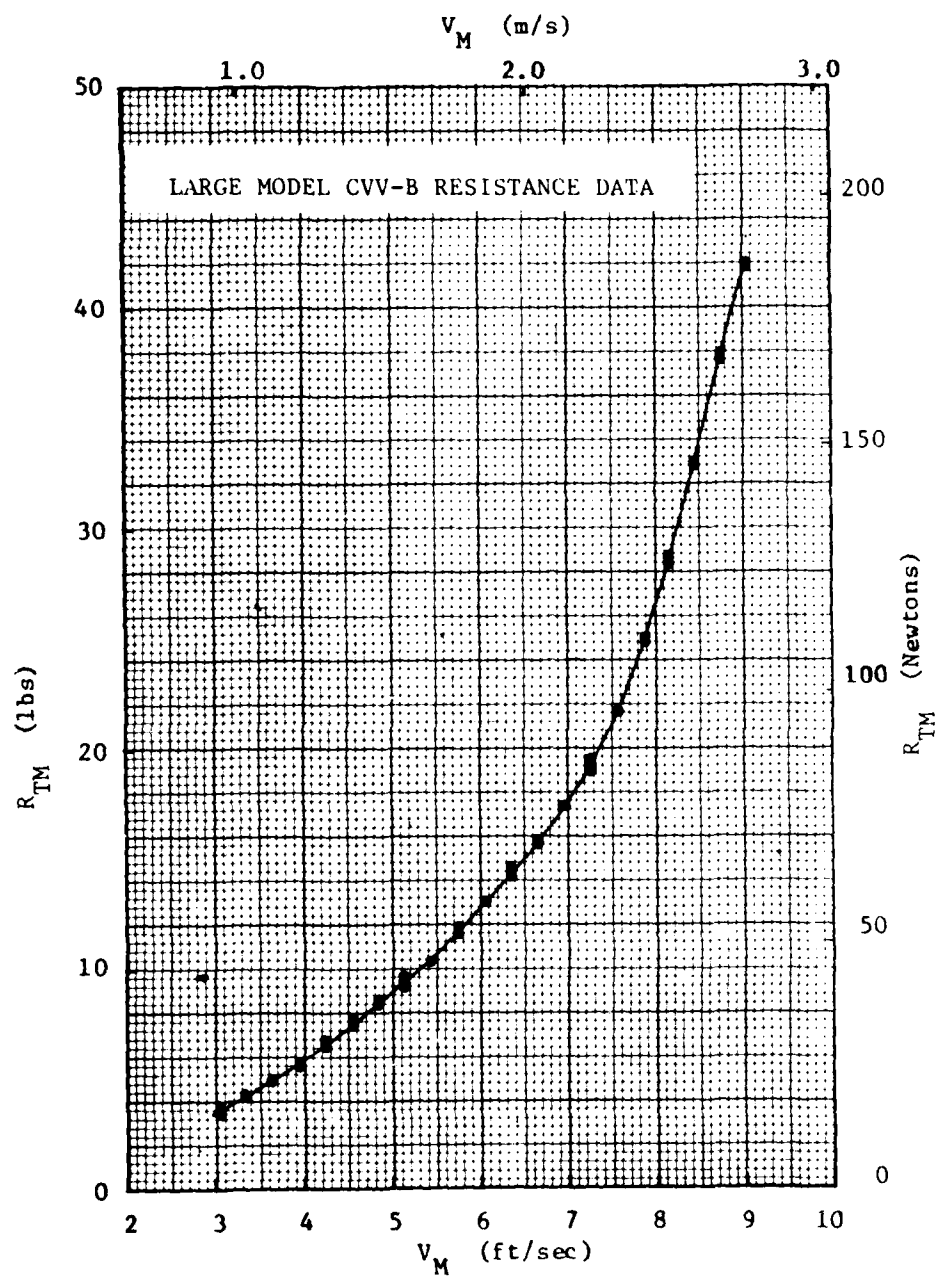


FIGURE 9 - RESISTANCE VALUES FOR THE LARGE CVV-B MODEL

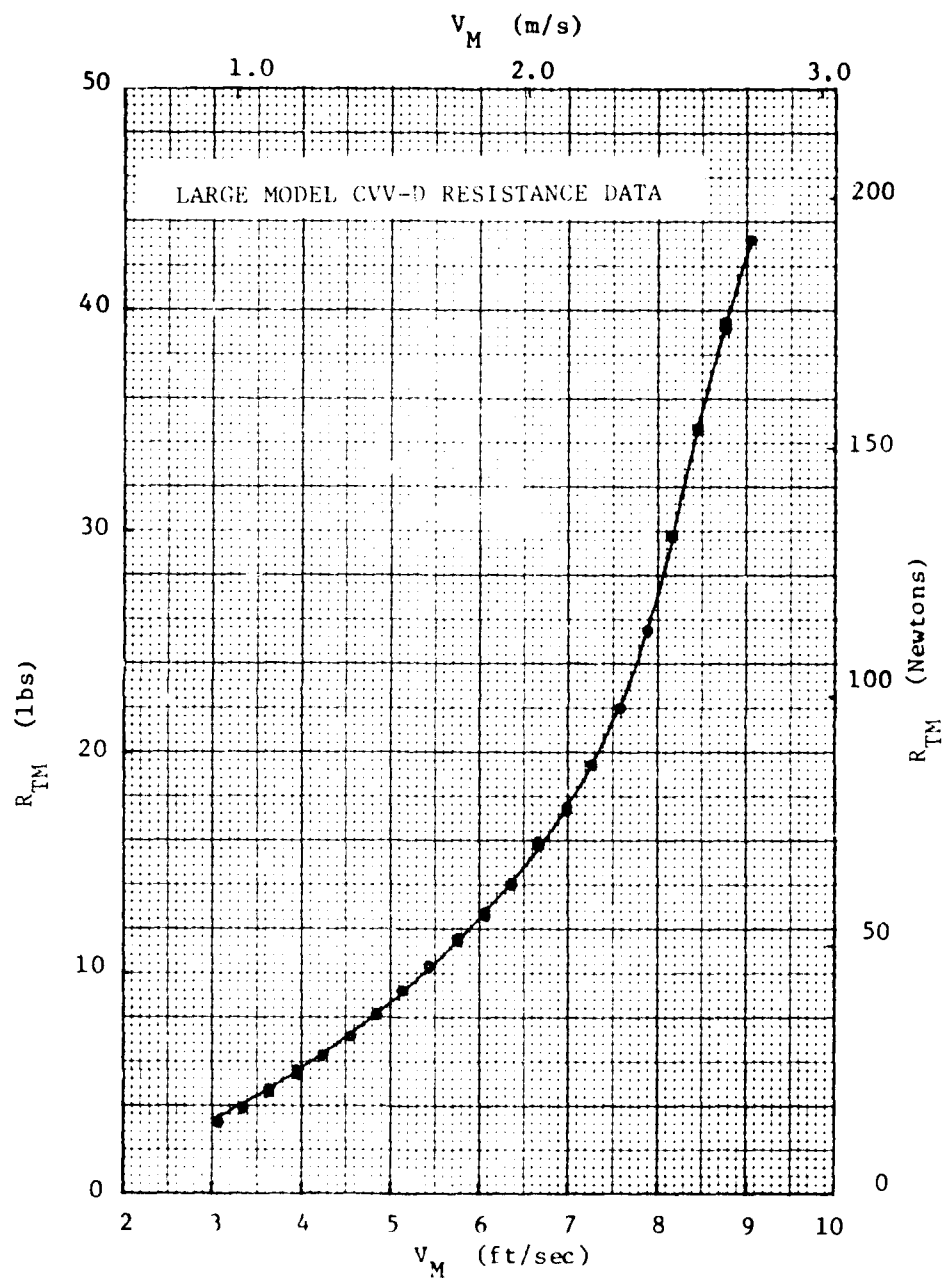


FIGURE 10 - RESISTANCE VALUES FOR THE LARGE CVV-D MODEL

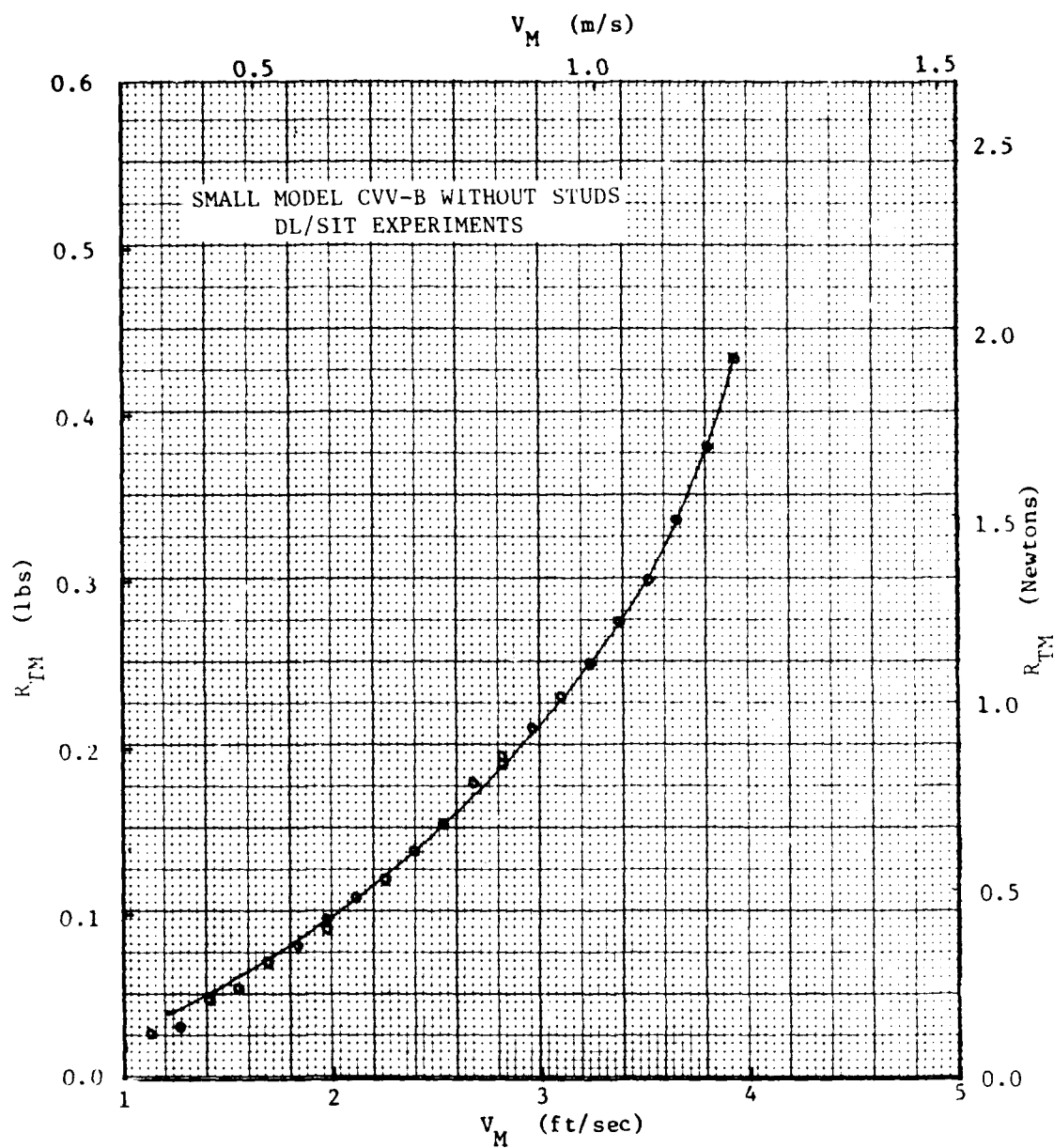


FIGURE 11 - RESISTANCE VALUES FOR THE SMALL CVV-B MODEL WITHOUT STUDS FROM DL/SIT

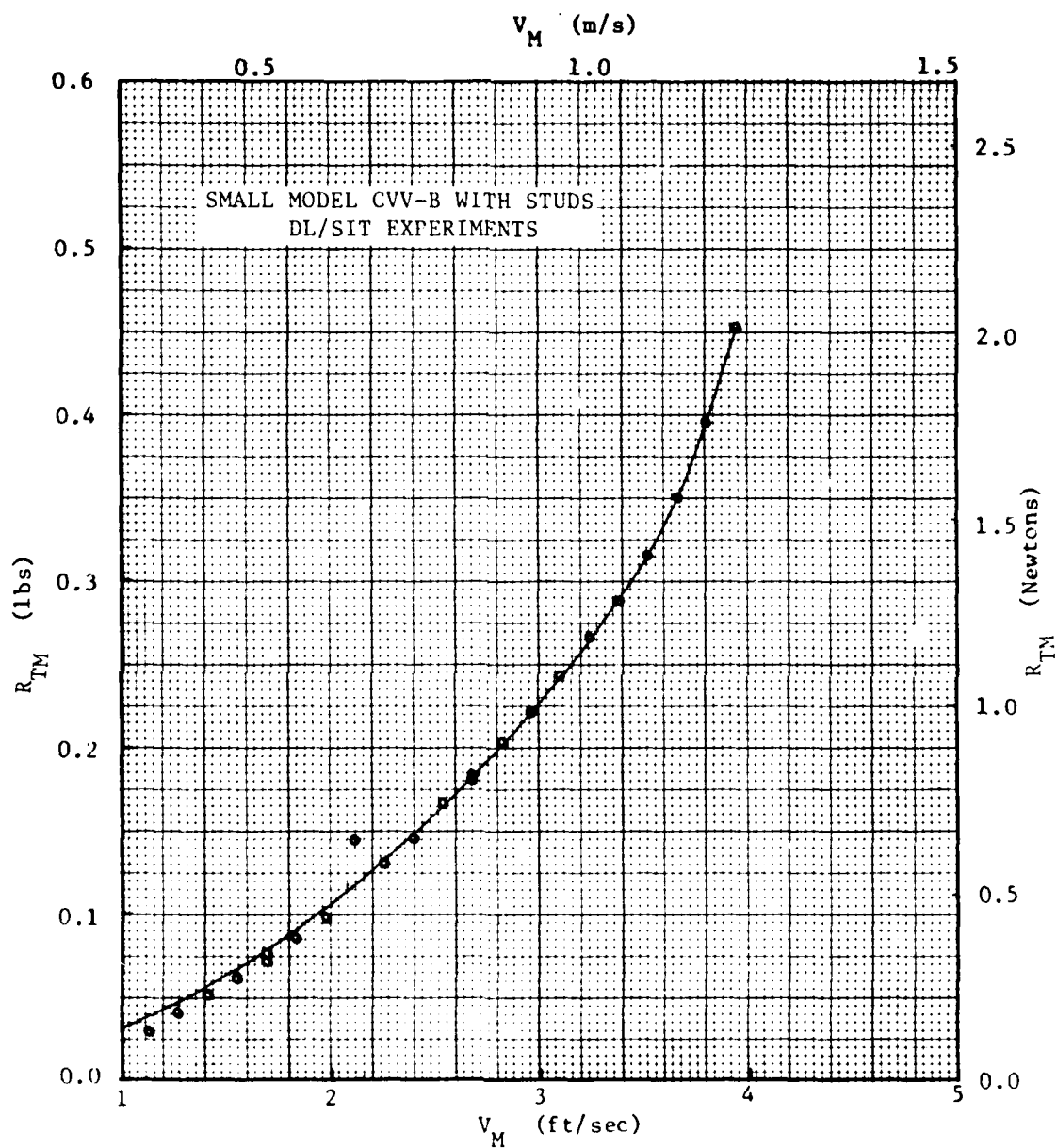


FIGURE 12 - RESISTANCE VALUES FOR THE SMALL CVV-B MODEL WITH STUDS
FROM DL/SIT

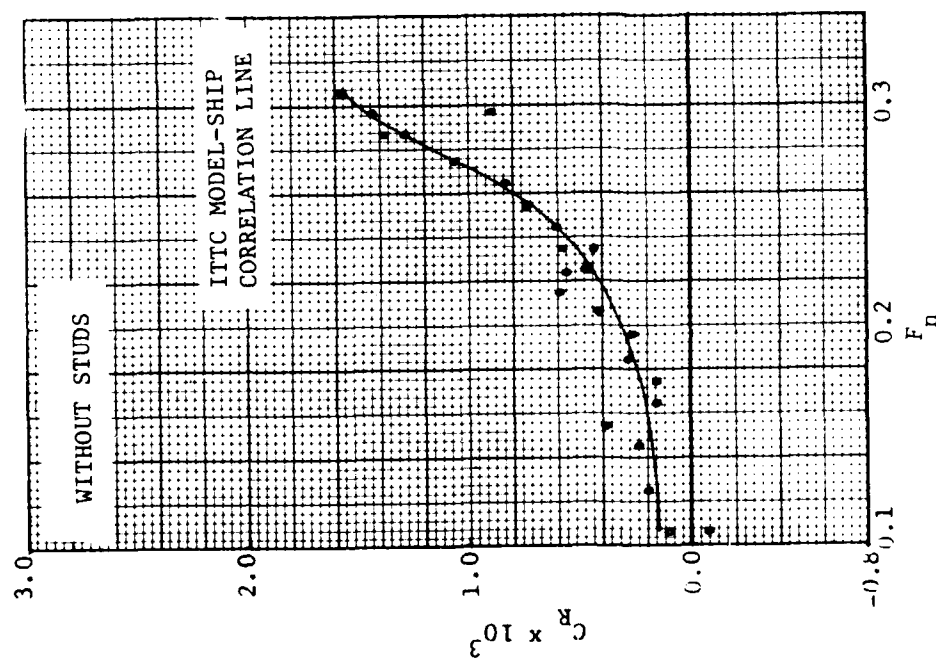
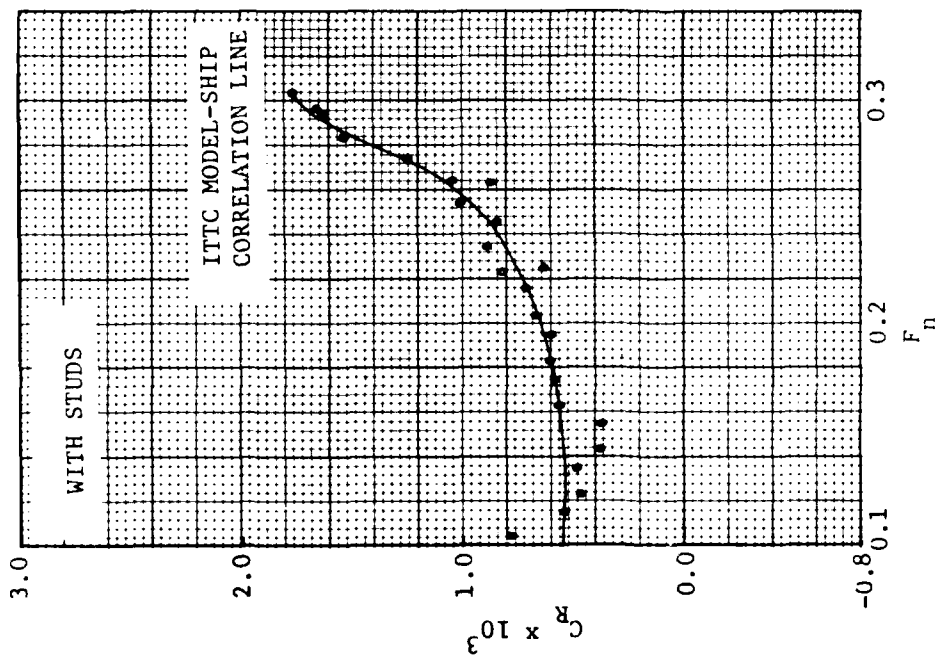


FIGURE 13 - RESIDUARY RESISTANCE COEFFICIENT CURVES FOR THE SMALL CVV-A MODEL FROM THE 140 FOOT BASIN EXPERIMENTS

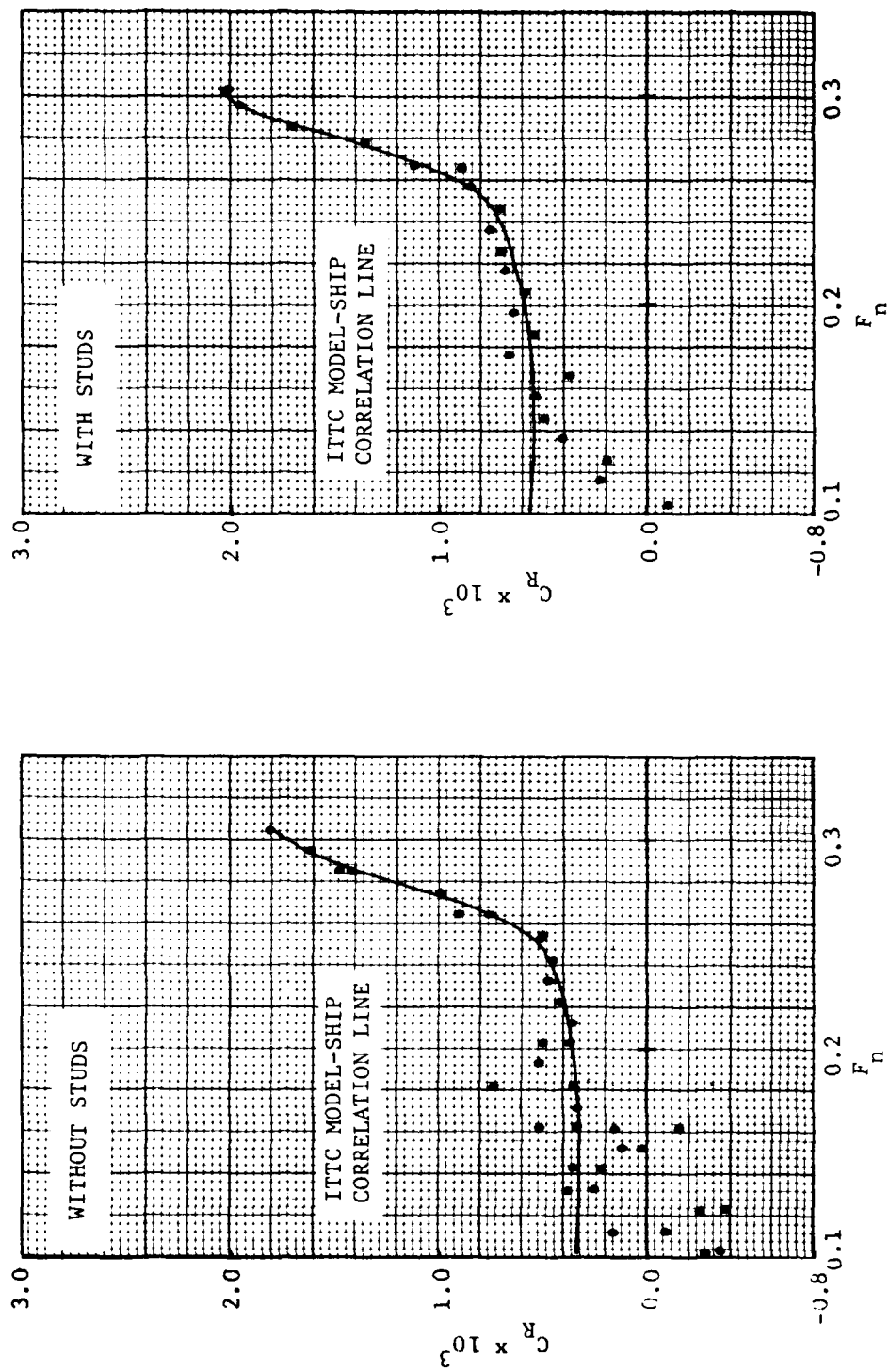


FIGURE 14 - RESIDUARY RESISTANCE COEFFICIENT CURVES FOR THE SMALL CVV-B
MODEL FROM THE 140 FOOT BASIN EXPERIMENTS

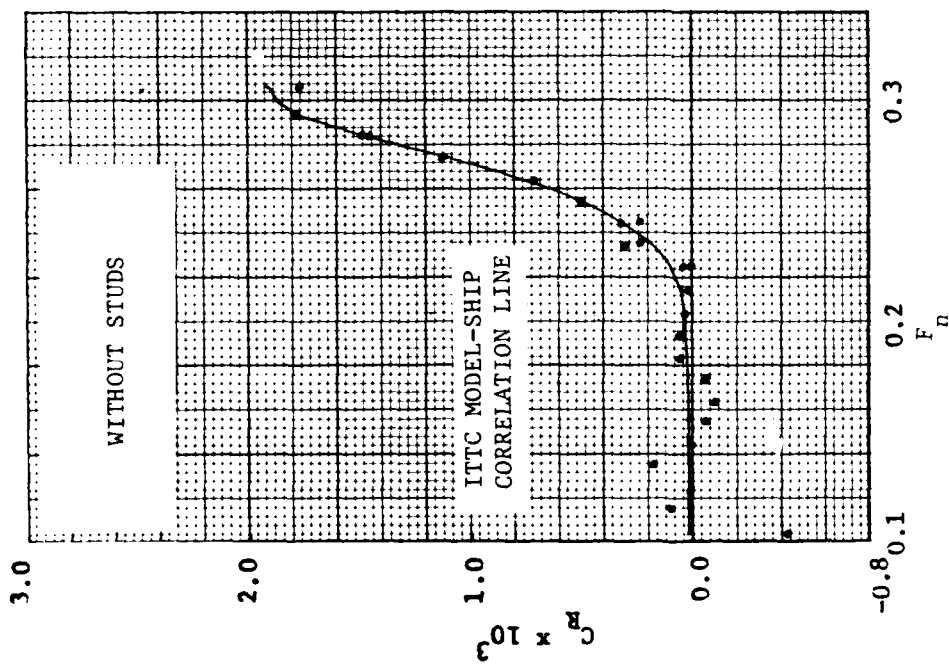
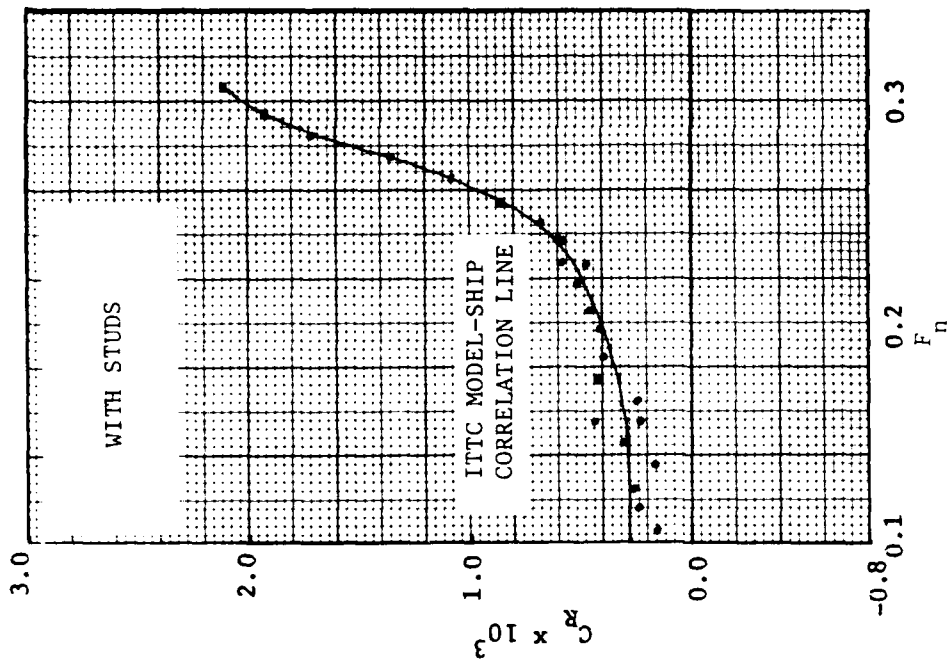


FIGURE 15 - RESIDUARY RESISTANCE COEFFICIENT CURVES FOR THE SMALL CVV-D
MODEL FROM THE 140 FOOT BASIN EXPERIMENTS

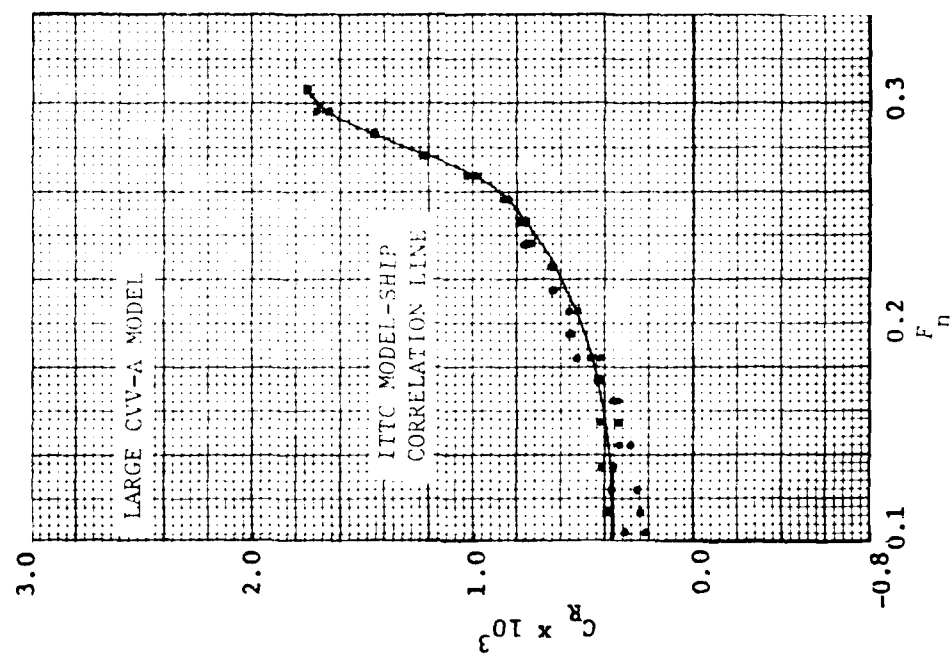


FIGURE 16 - RESIDUARY RESISTANCE COEFFICIENT CURVES FOR THE LARGE CVV-A MODEL

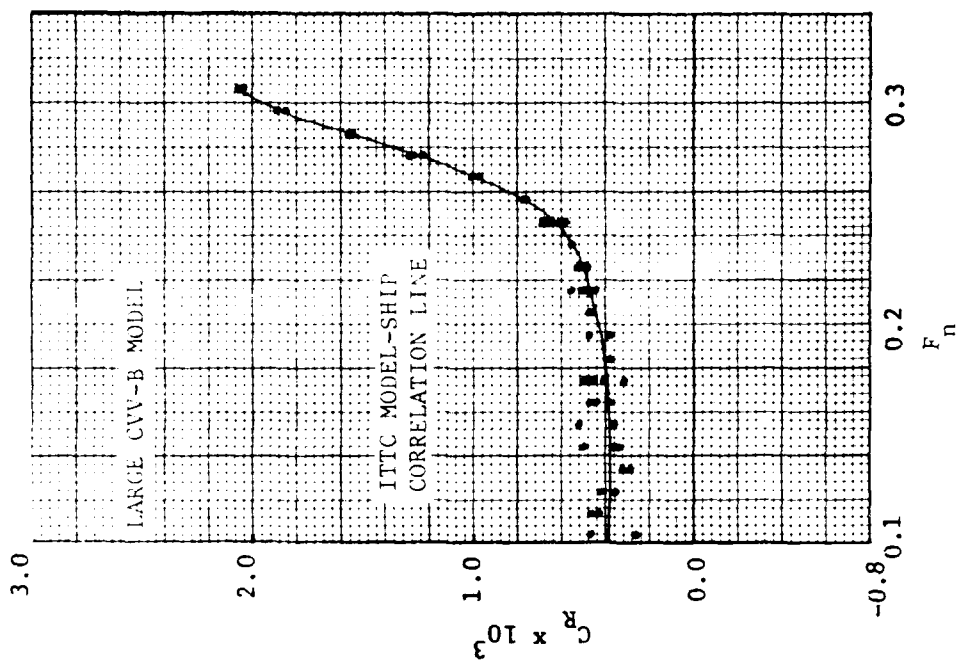


FIGURE 17 - RESIDUARY RESISTANCE COEFFICIENT CURVES FOR THE LARGE CVV-B MODEL

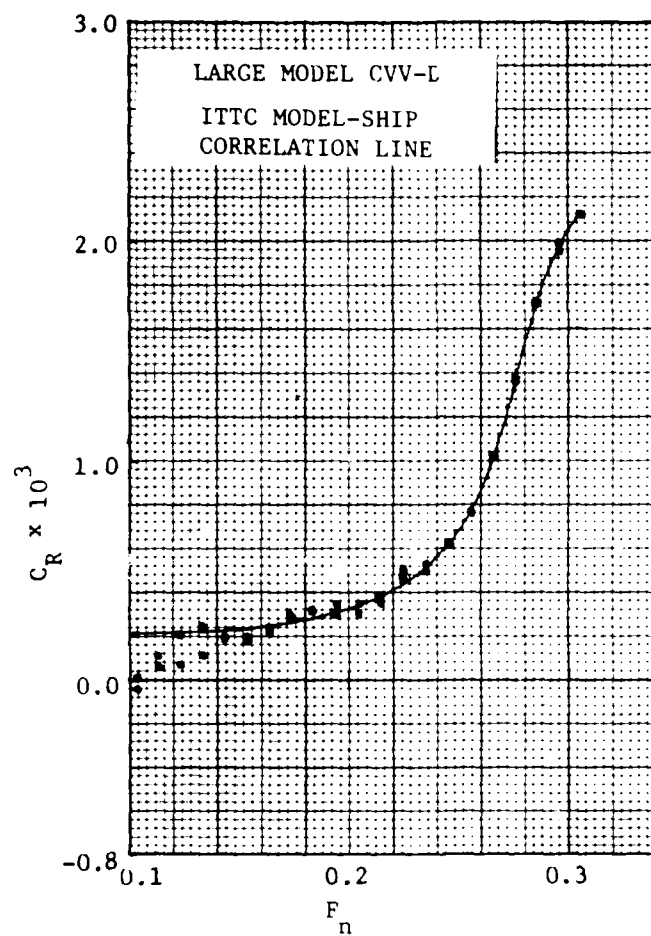


FIGURE 18 - RESIDUARY RESISTANCE COEFFICIENT CURVE FOR THE LARGE CVV-D MODEL

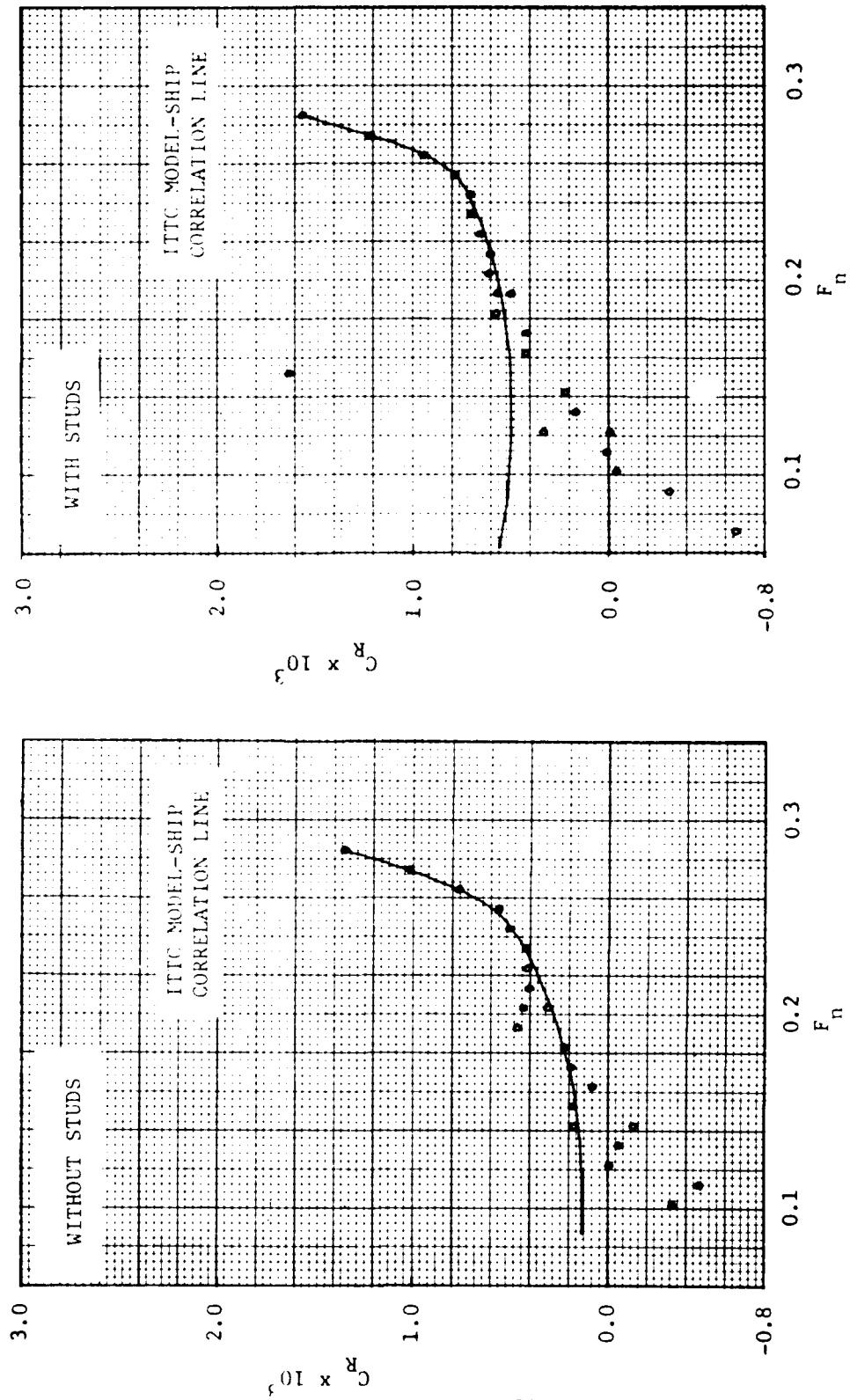


FIGURE 19 - RESIDUARY RESISTANCE COEFFICIENT CURVES FOR THE SMALL CVV-B MODEL FROM DL/SIT

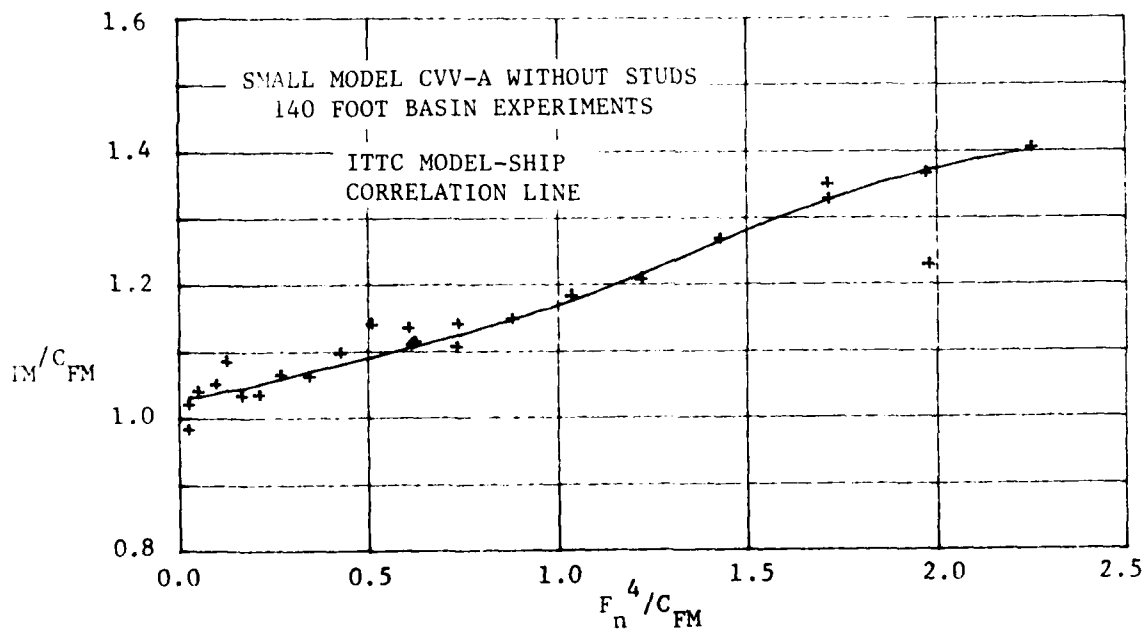
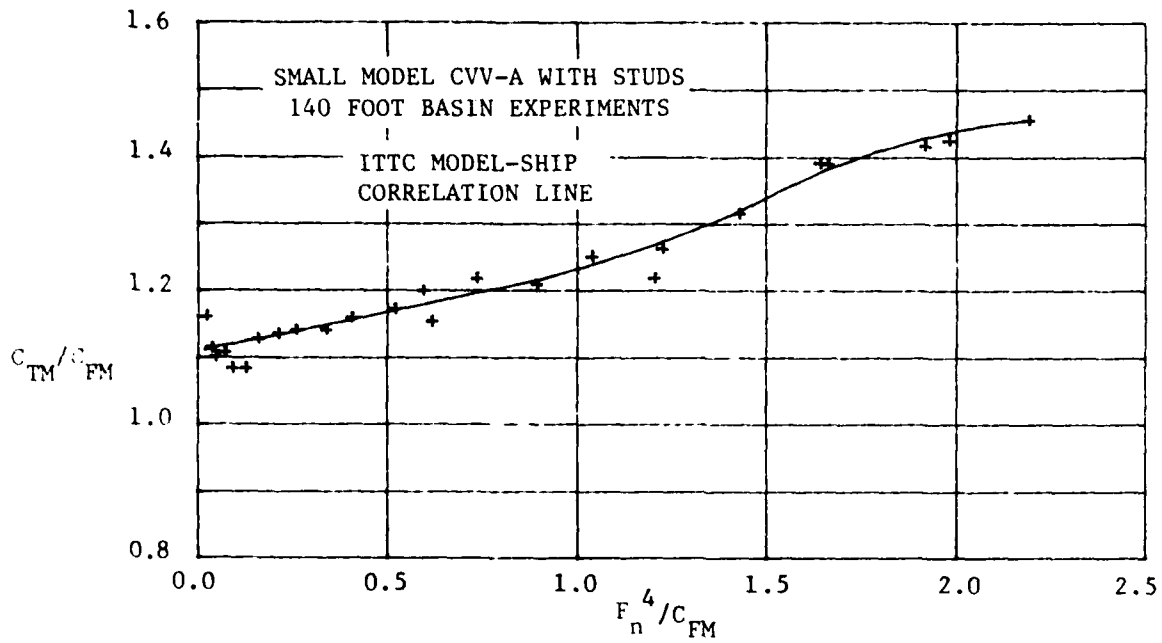


FIGURE 20 - PROHASKA PLOTS FOR THE SMALL CVV-A MODEL FROM
THE 140 FOOT BASIN EXPERIMENTS

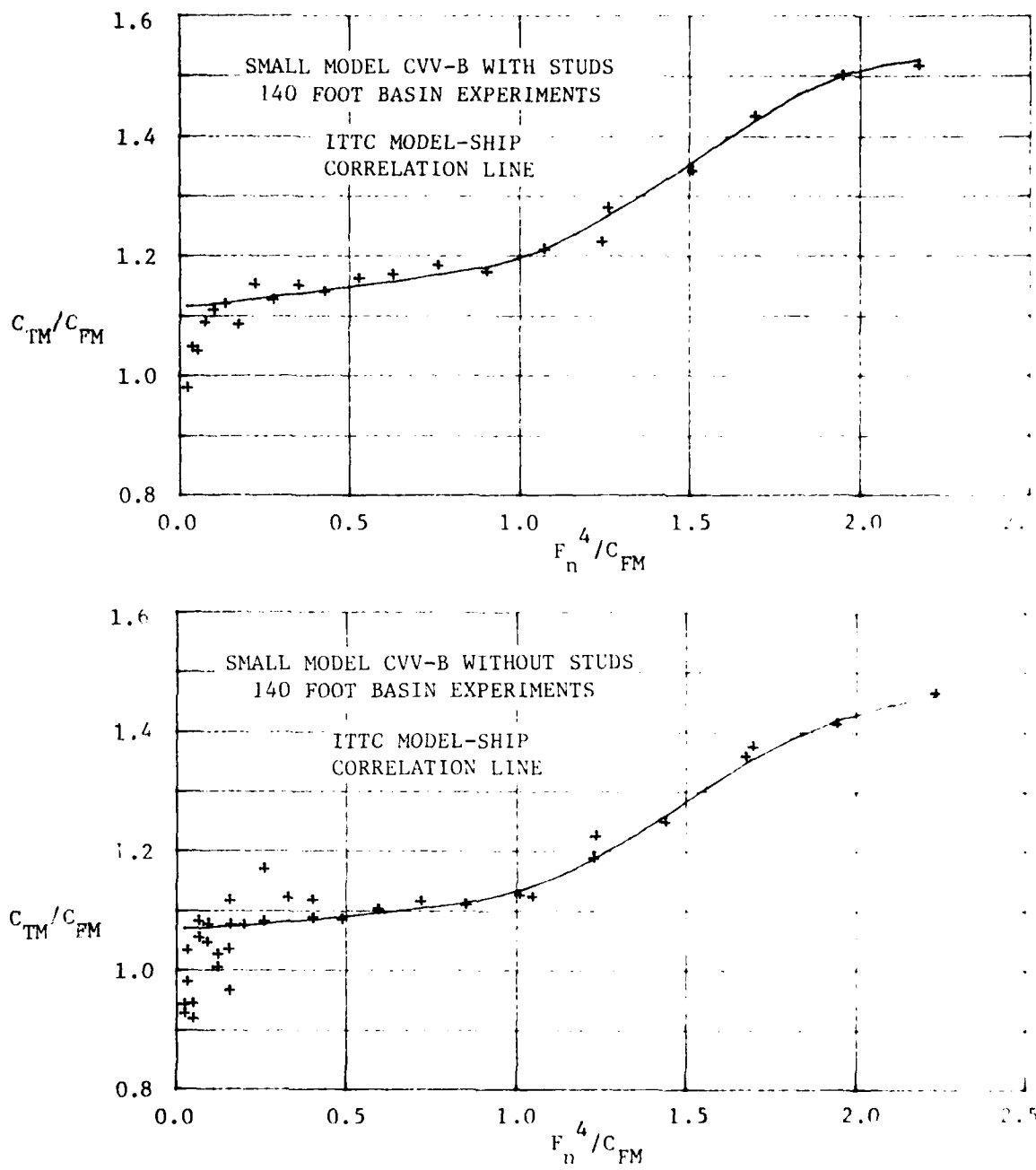


FIGURE 21 - PROHASKA PLOTS FOR THE SMALL CVV-B MODEL FROM THE 140 FOOT BASIN EXPERIMENTS

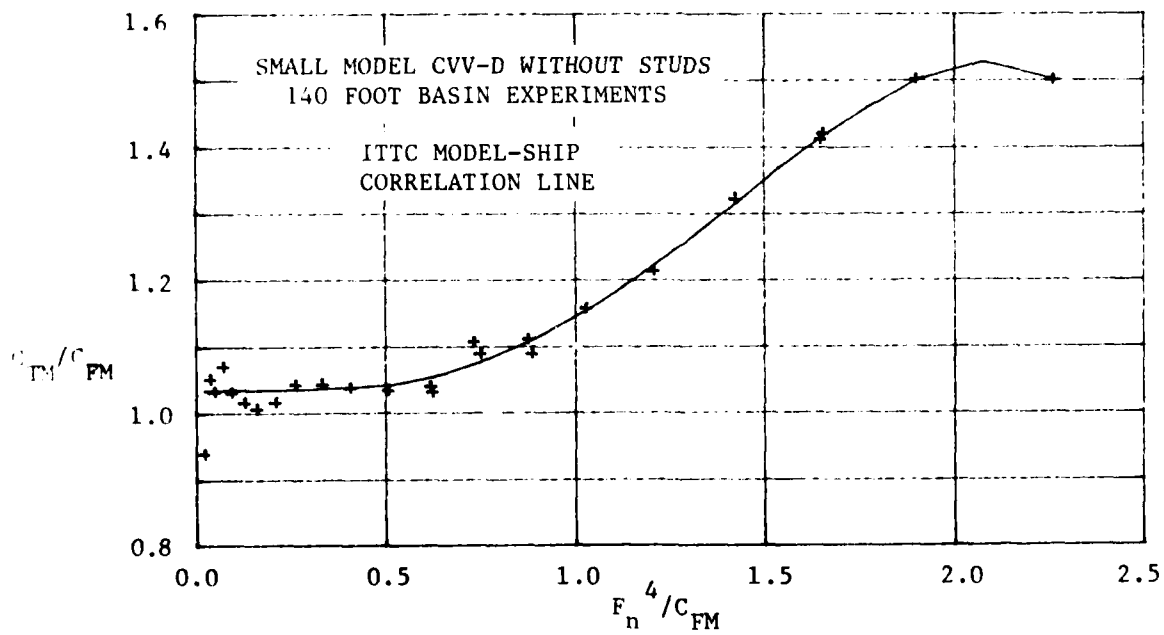
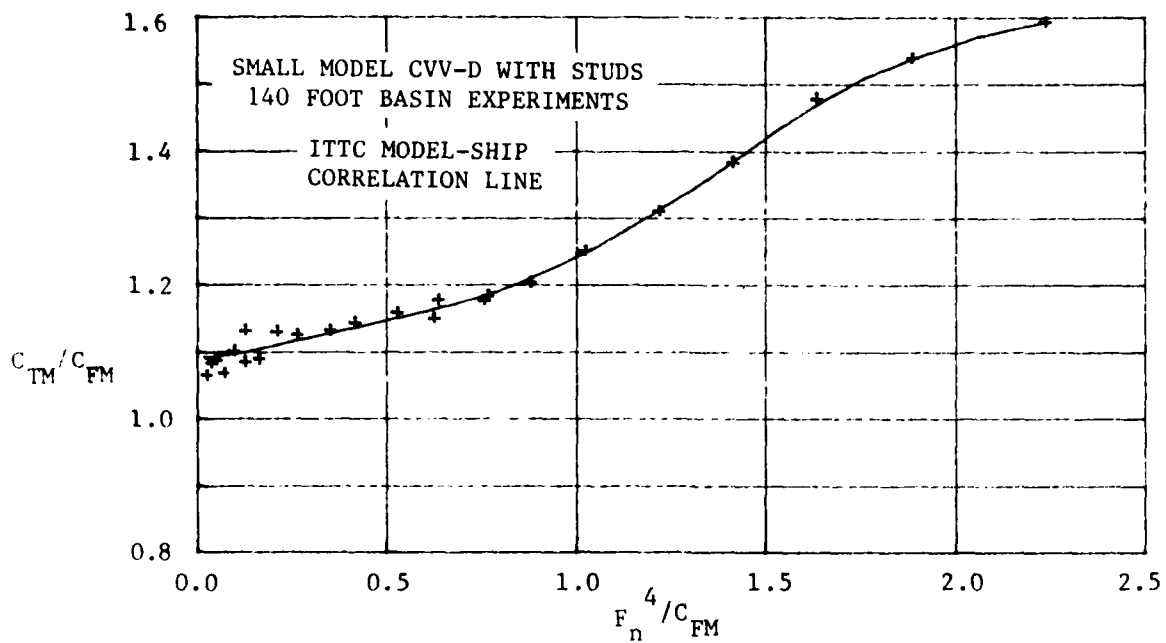


FIGURE 22 - PROHASKA PLOTS FOR THE SMALL CVV-D MODEL FROM
THE 140 FOOT BASIN EXPERIMENTS

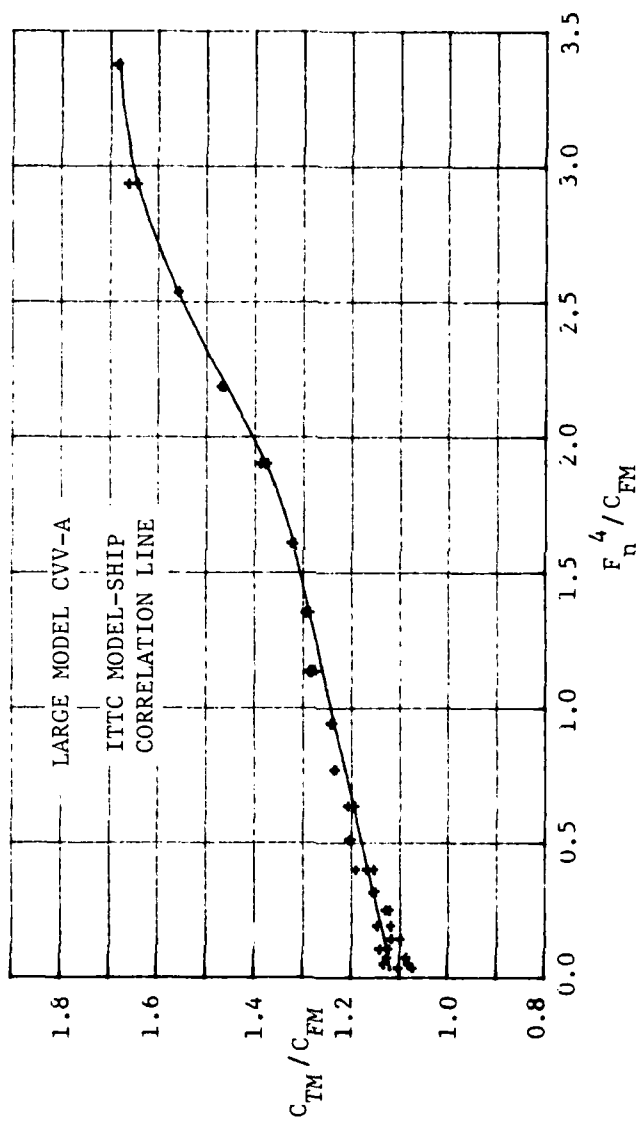


FIGURE 23 - PROHASKA PLOT FOR THE LARGE CVV-A MODEL

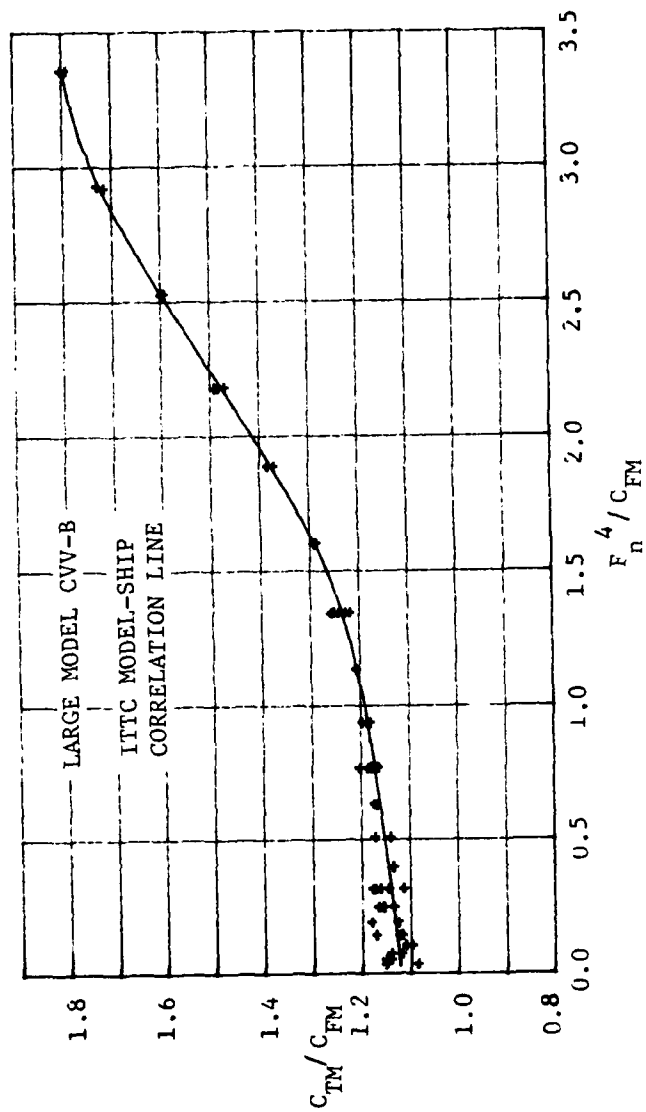


FIGURE 24 - PROHASKA PLOT FOR THE LARGE CVV-E MODEL

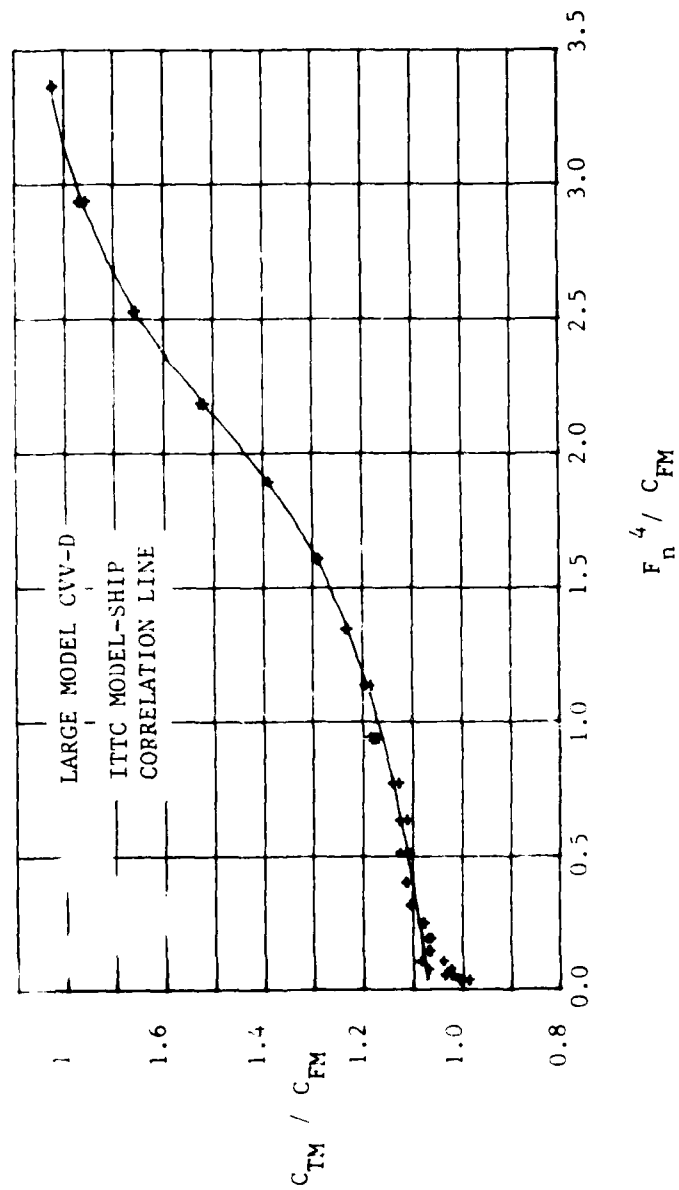
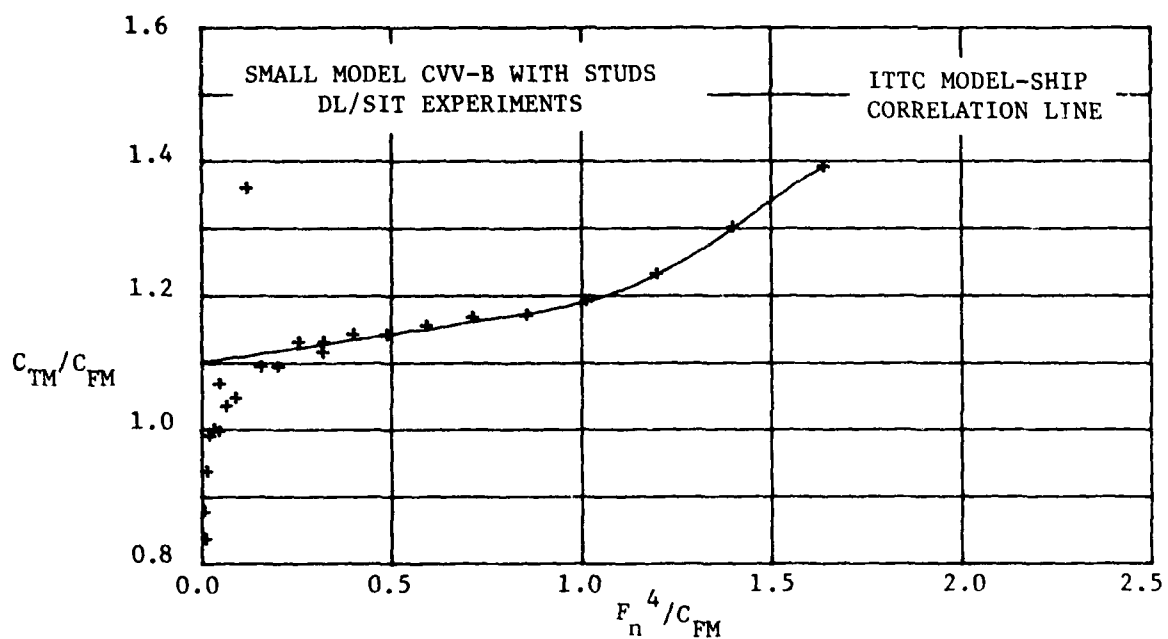


FIGURE 25 - PROHASKA PLOT FOR THE LARGE CVV-D MODEL



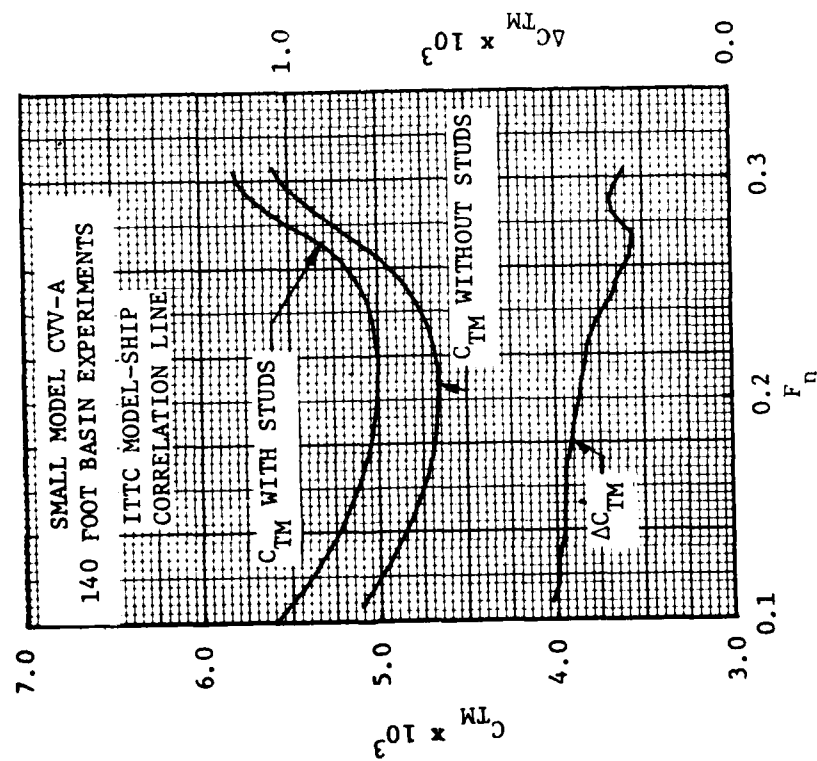


FIGURE 27 - TOTAL RESISTANCE COEFFICIENT CURVES FOR THE SMALL CWV-A MODEL

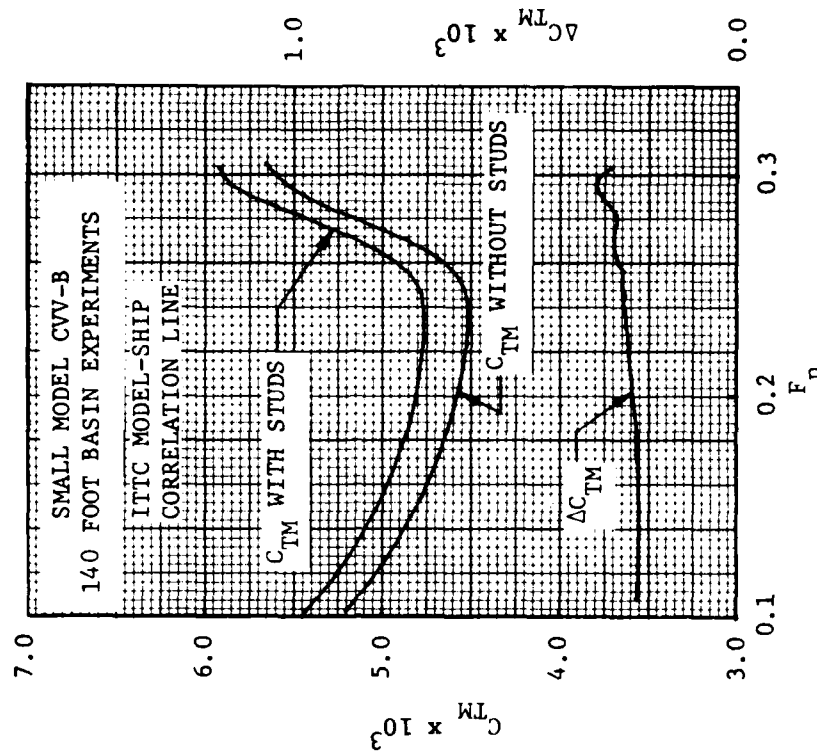


FIGURE 28 - TOTAL RESISTANCE COEFFICIENT CURVES FOR THE SMALL CWV-B MODEL

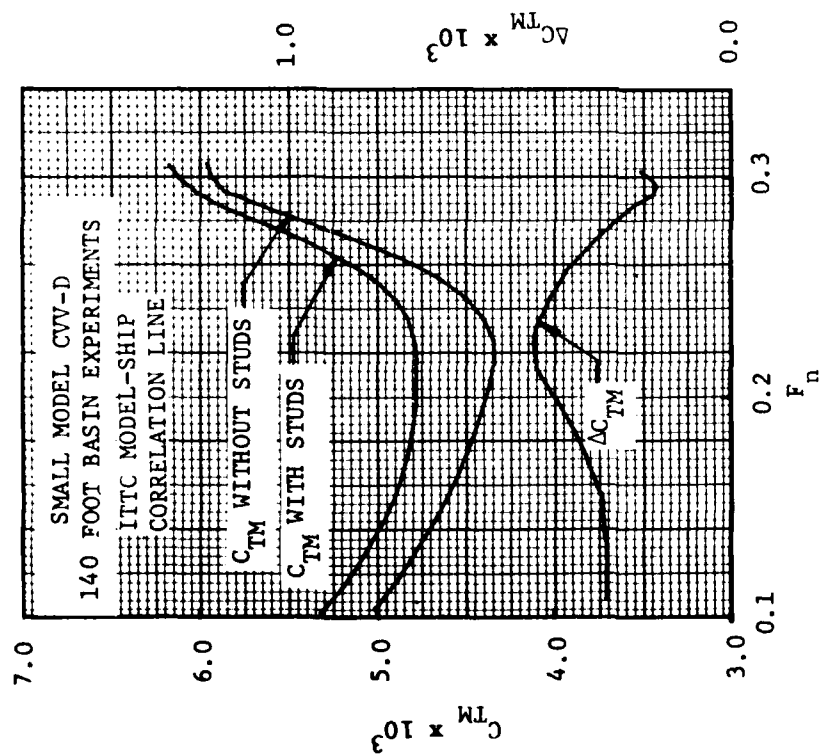


FIGURE 29 - TOTAL RESISTANCE COEFFICIENT CURVES FOR THE SMALL CVV-D MODEL

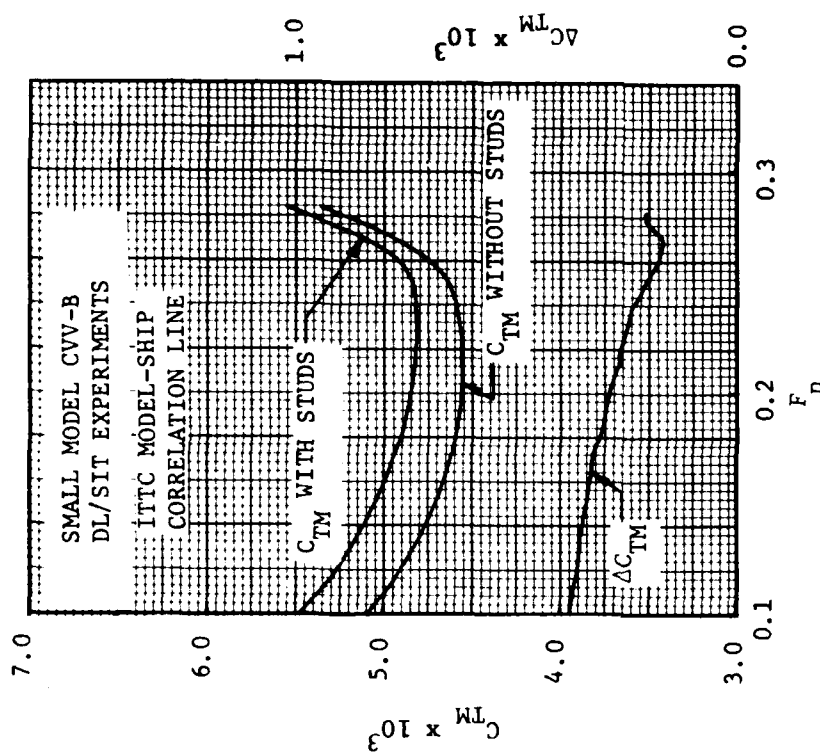


FIGURE 30 - TOTAL RESISTANCE COEFFICIENT CURVES FOR THE SMALL CVV-B MODEL FROM DL/SIT

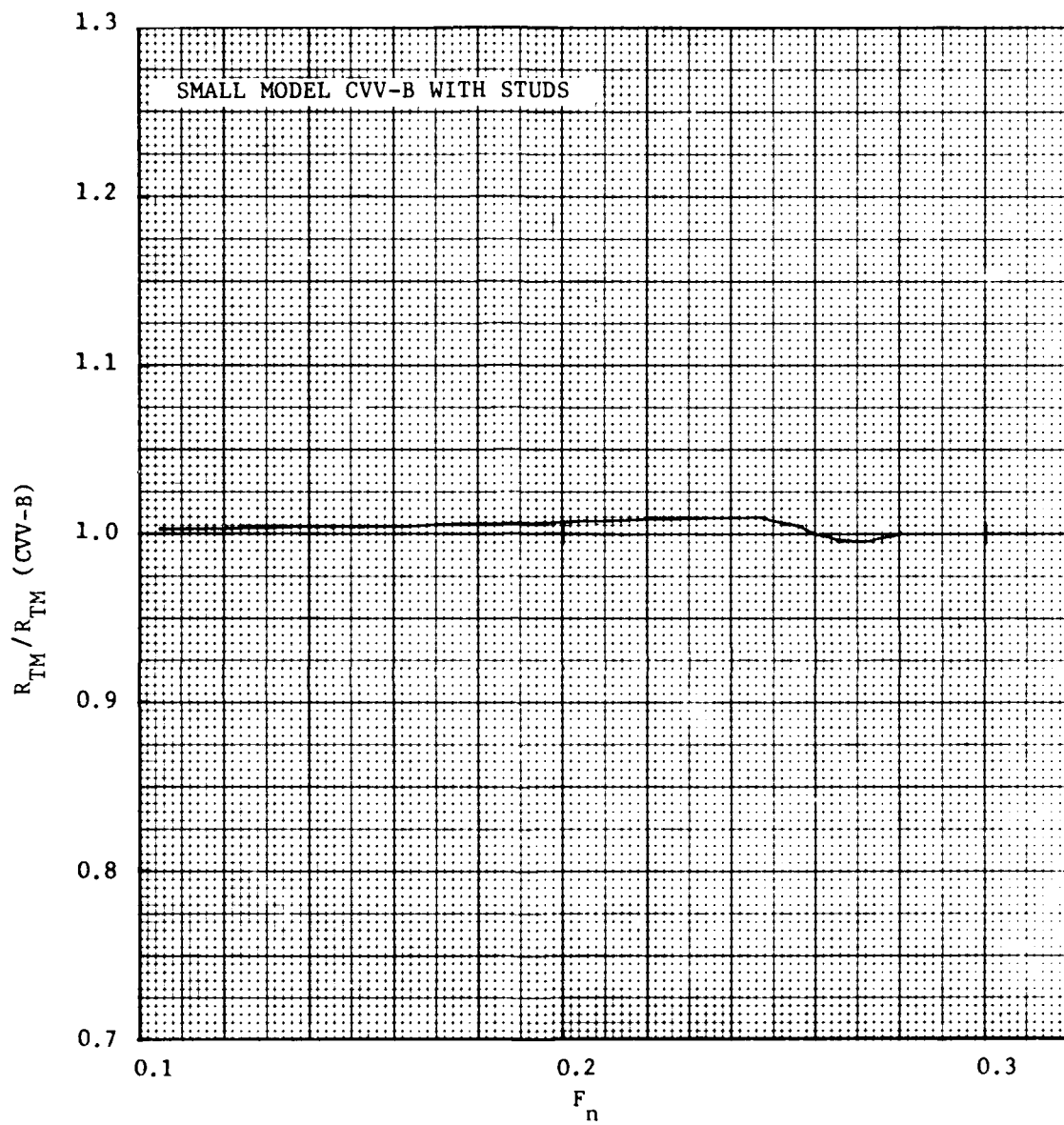


FIGURE 31 - $R_{TM} (DL/SIT) / R_{TM} (DTNSRDC)$ FOR THE SMALL CVV-B MODEL

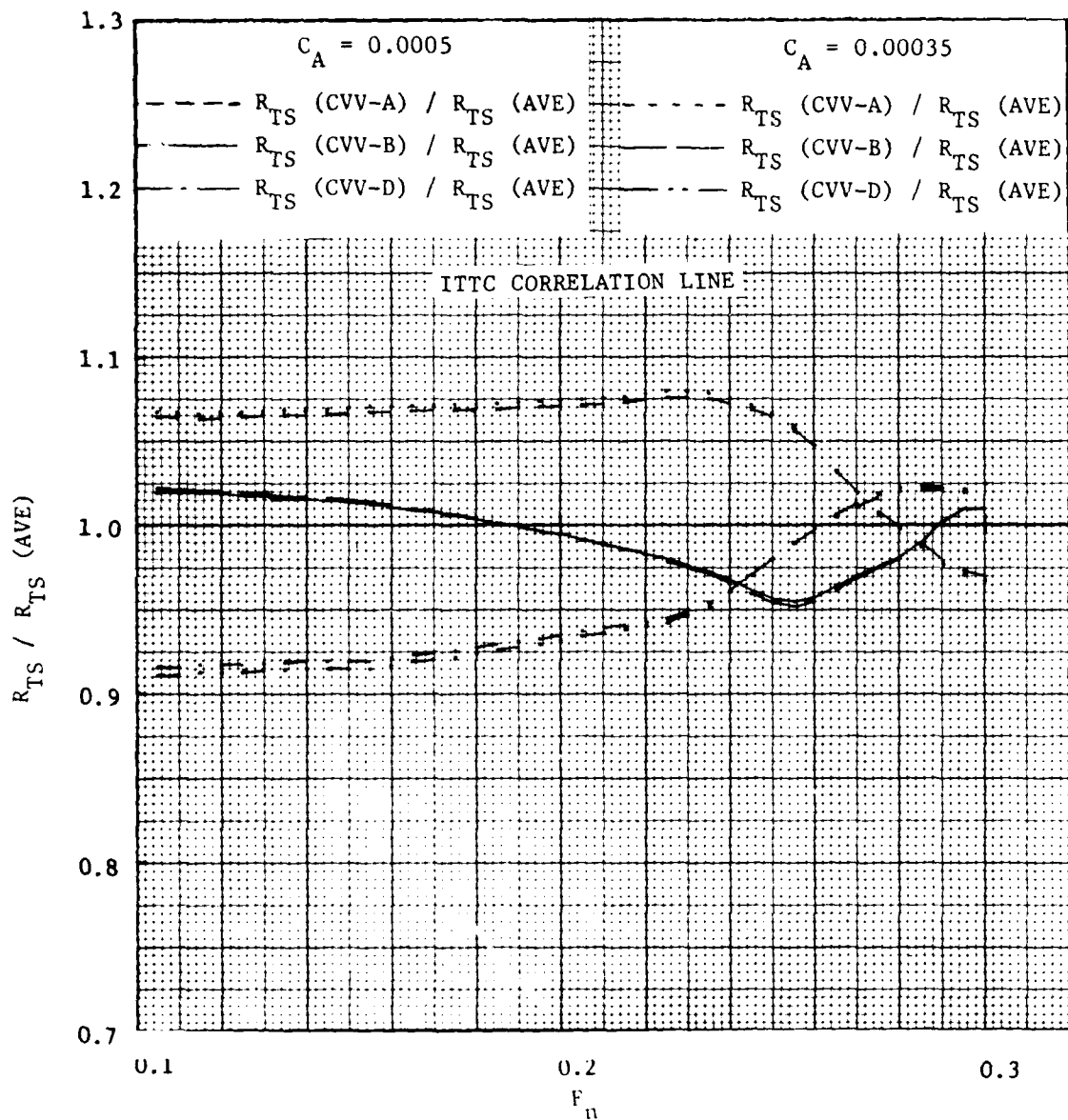


FIGURE 32 - $R_{TS} / R_{TS} (AVE)$ VERSUS FROUDE NUMBER FOR THE SMALL CVV MODELS
FROM THE 140 FOOT BASIN EXPERIMENTS

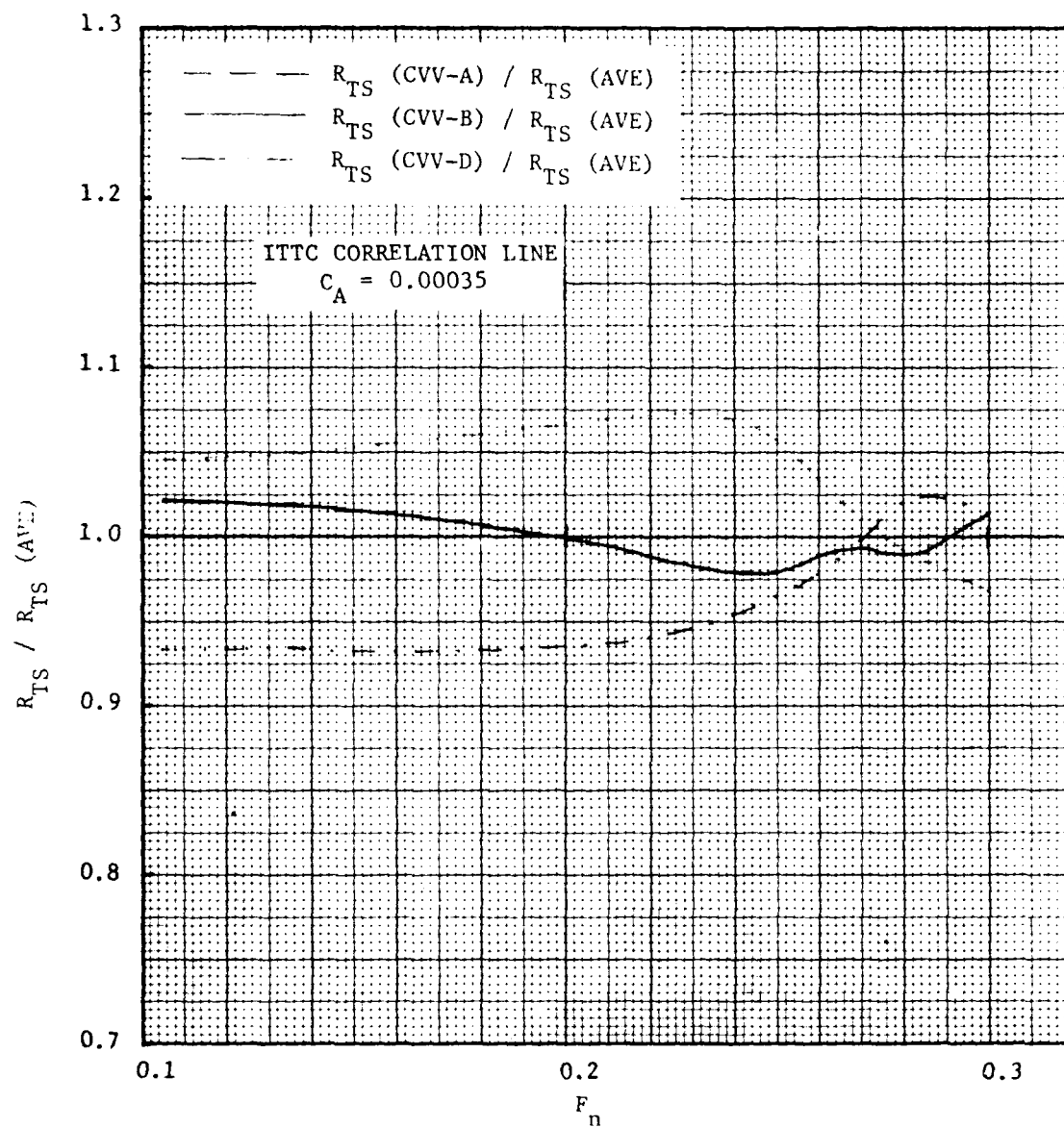


FIGURE 33 - $R_{TS} / R_{TS} \text{ (AVE)}$ VERSUS FROUDE NUMBER FOR THE LARGE CVV MODELS

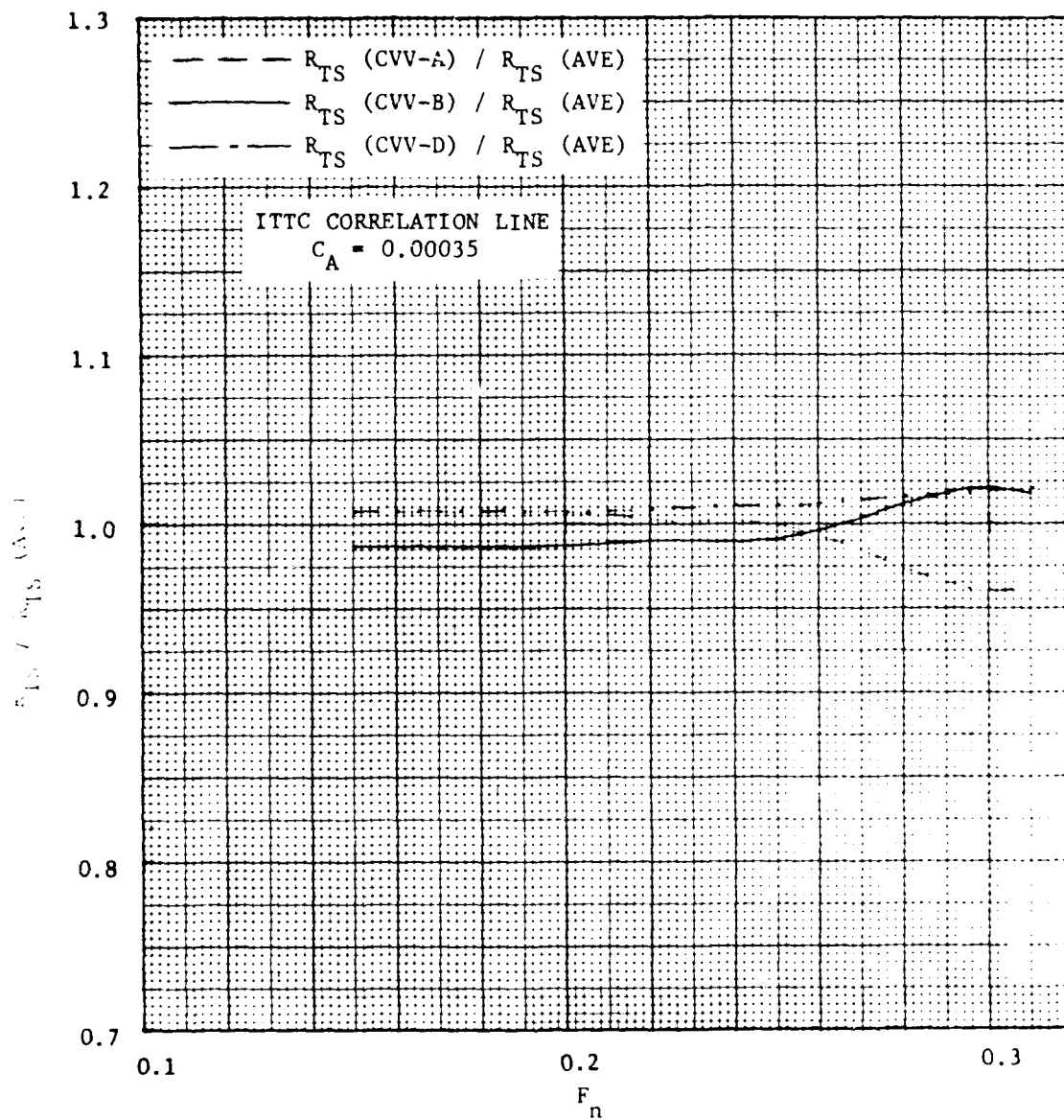


FIGURE 34 - $R_{TS} / R_{TS} (AVE)$ VERSUS FROUDE NUMBER USING TAYLOR STANDARD SERIES PREDICTIONS

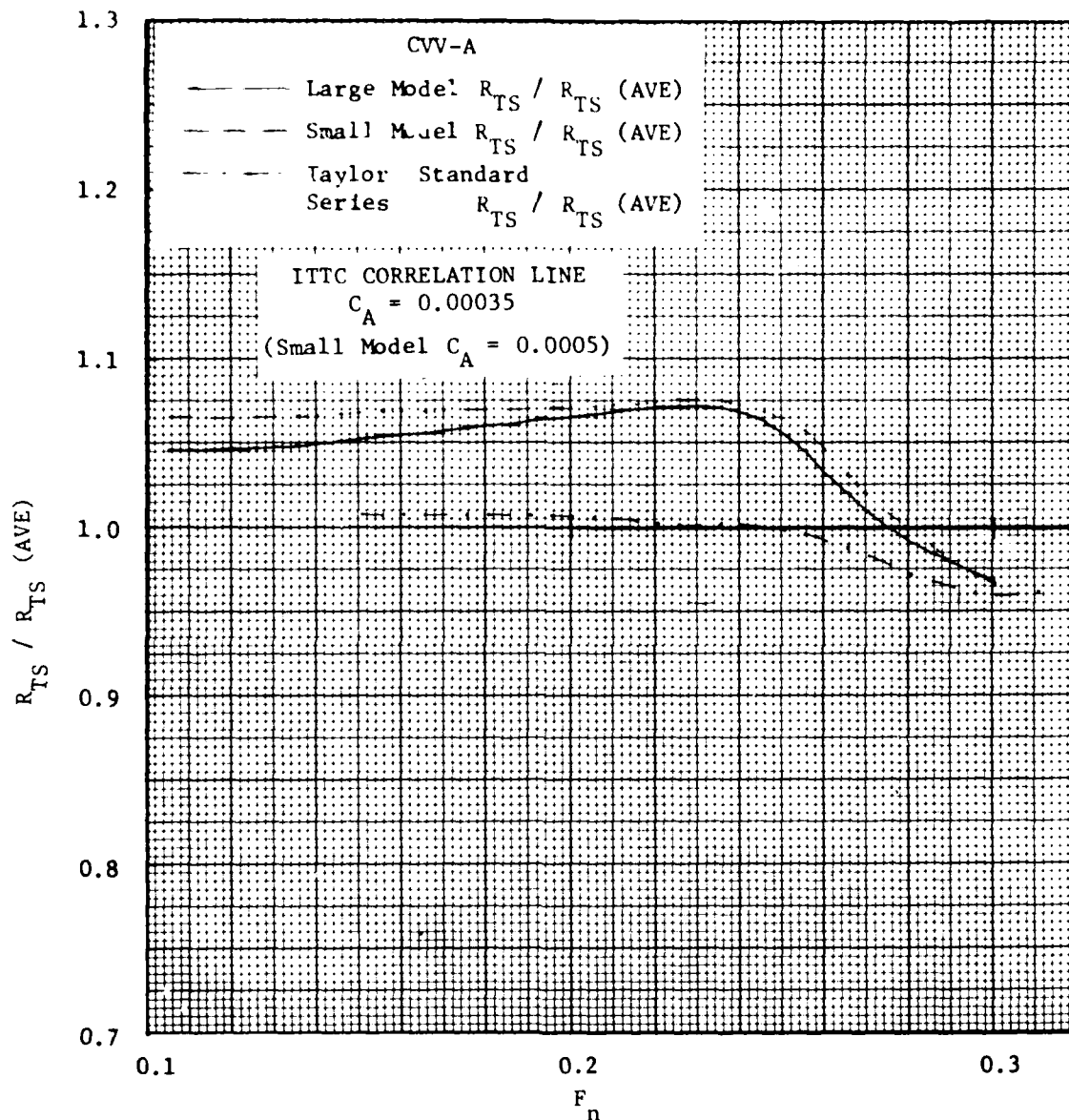


FIGURE 35 - R_{TS} / R_{TS} (AVE) VERSUS FROUDE NUMBER FOR CVV-A

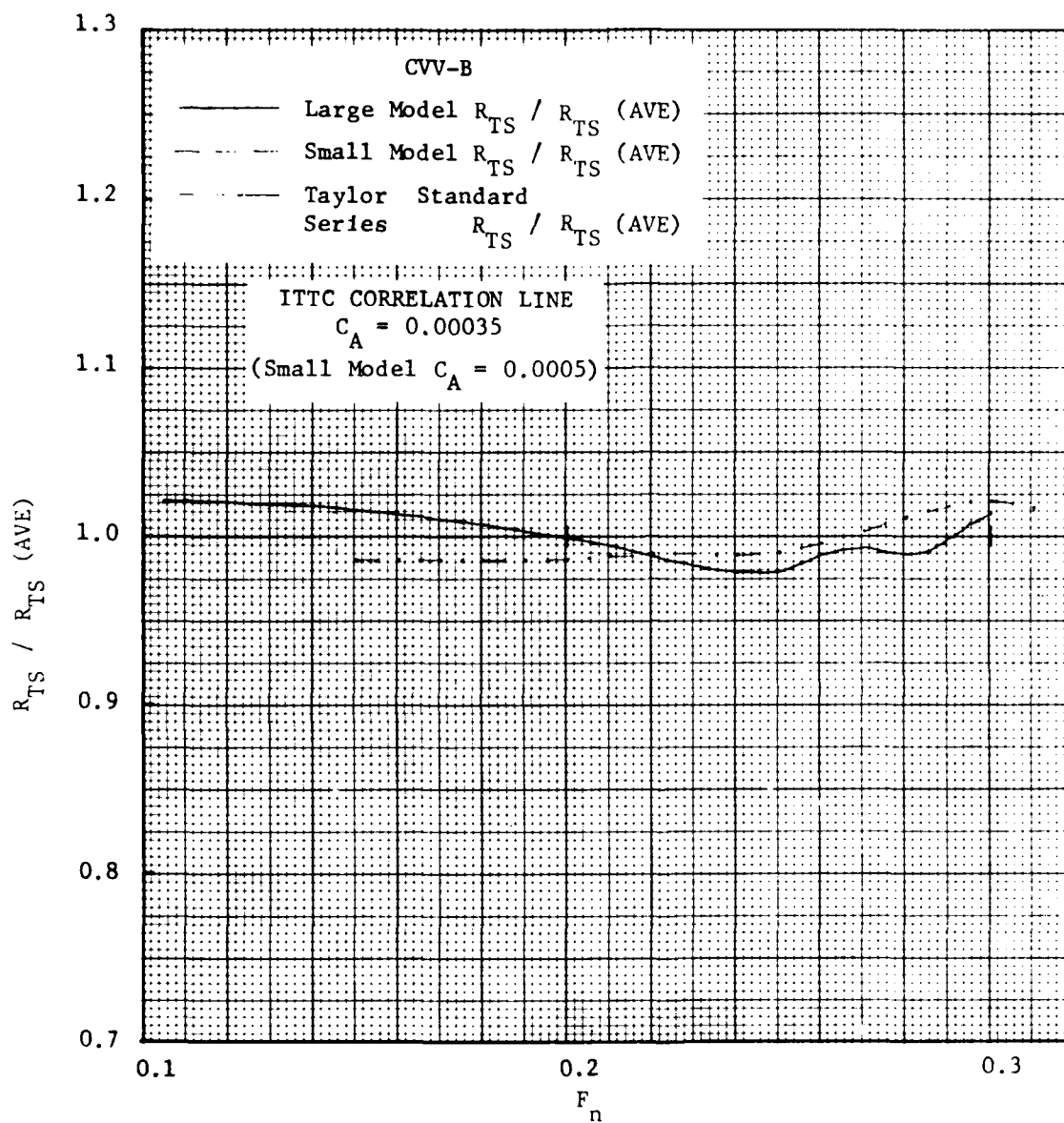


FIGURE 36 - $R_{TS} / R_{TS} (AVE)$ VERSUS FROUDE NUMBER FOR CVV-B

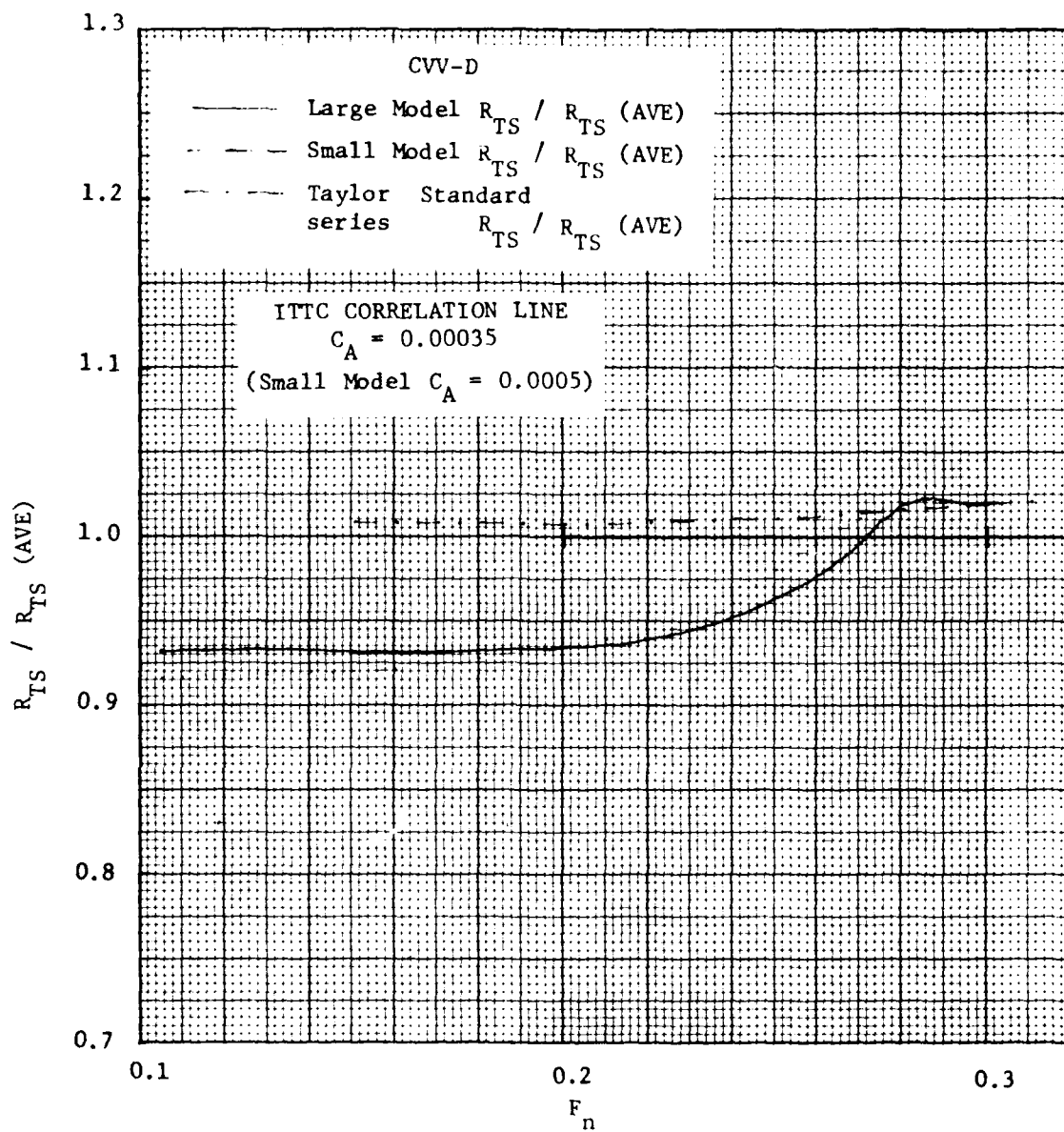


FIGURE 37 - $R_{TS} / R_{TS} (AVE)$ VERSUS FROUDE NUMBER FOR CVV-D

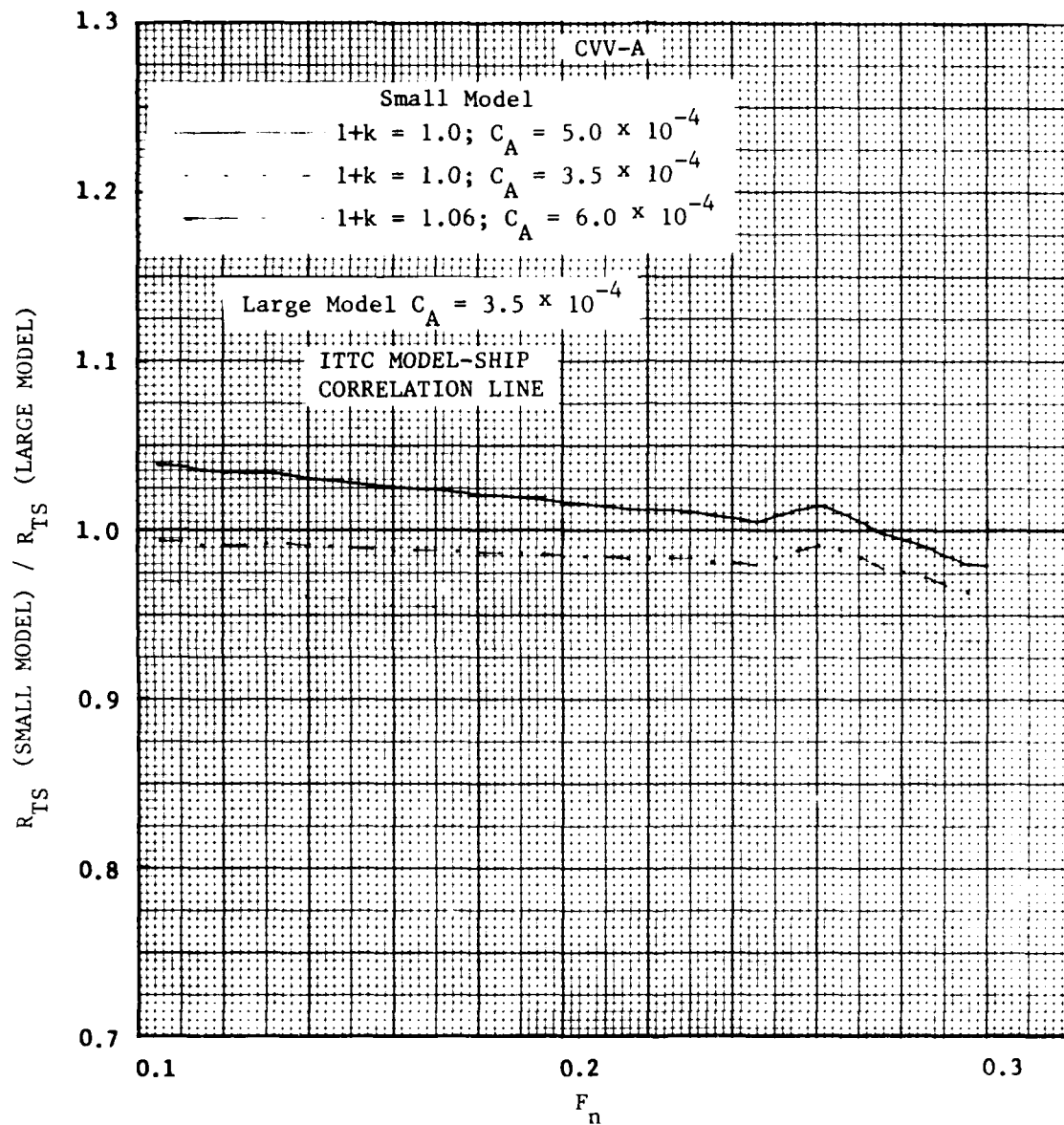


FIGURE 38 - $R_{TS} \text{ (SMALL MODEL)} / R_{TS} \text{ (LARGE MODEL)}$ FOR THE CVV-A MODELS

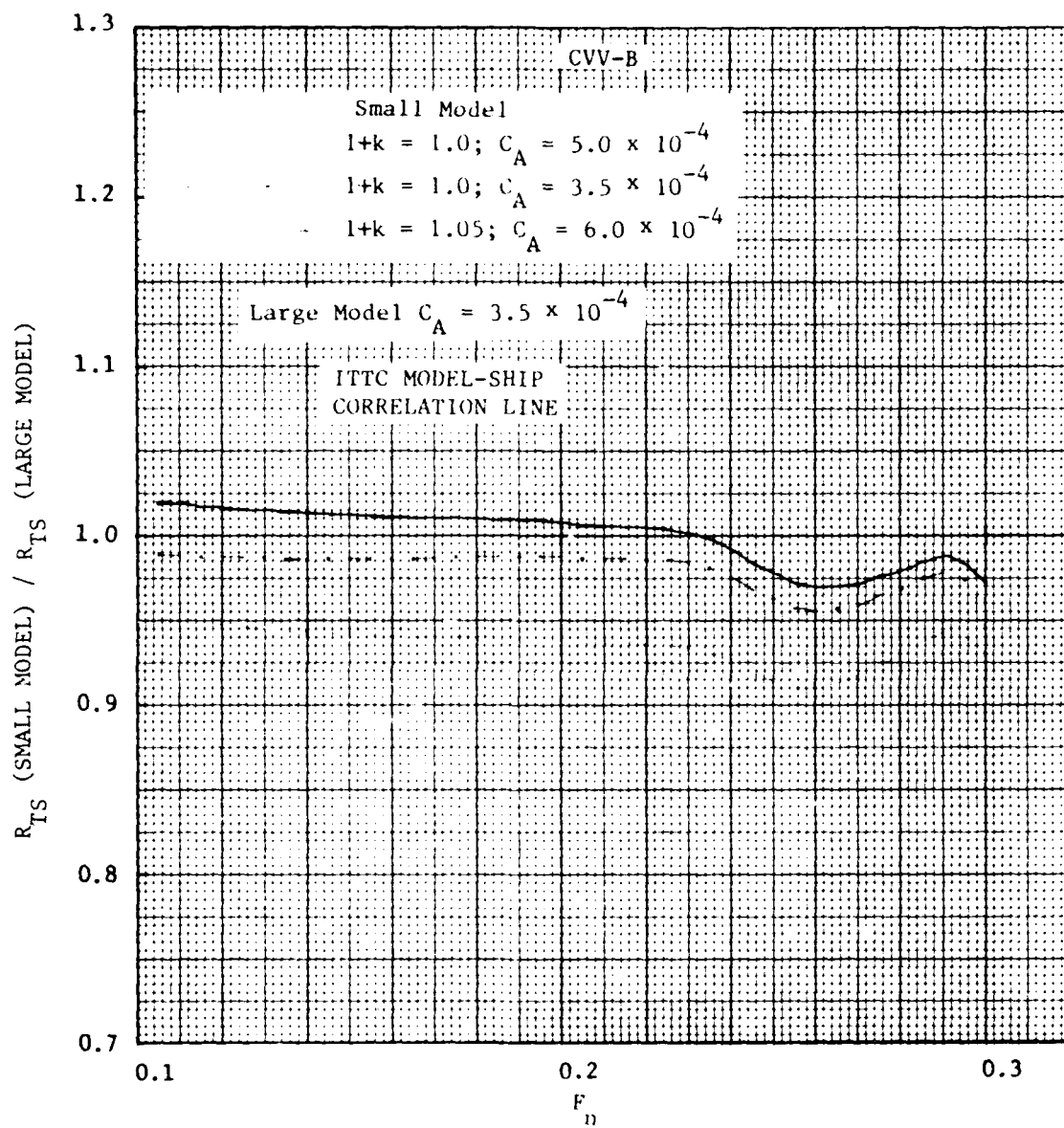


FIGURE 39 - $R_{TS} \text{ (SMALL MODEL)} / R_{TS} \text{ (LARGE MODEL)}$ FOR THE CVV-B MODELS

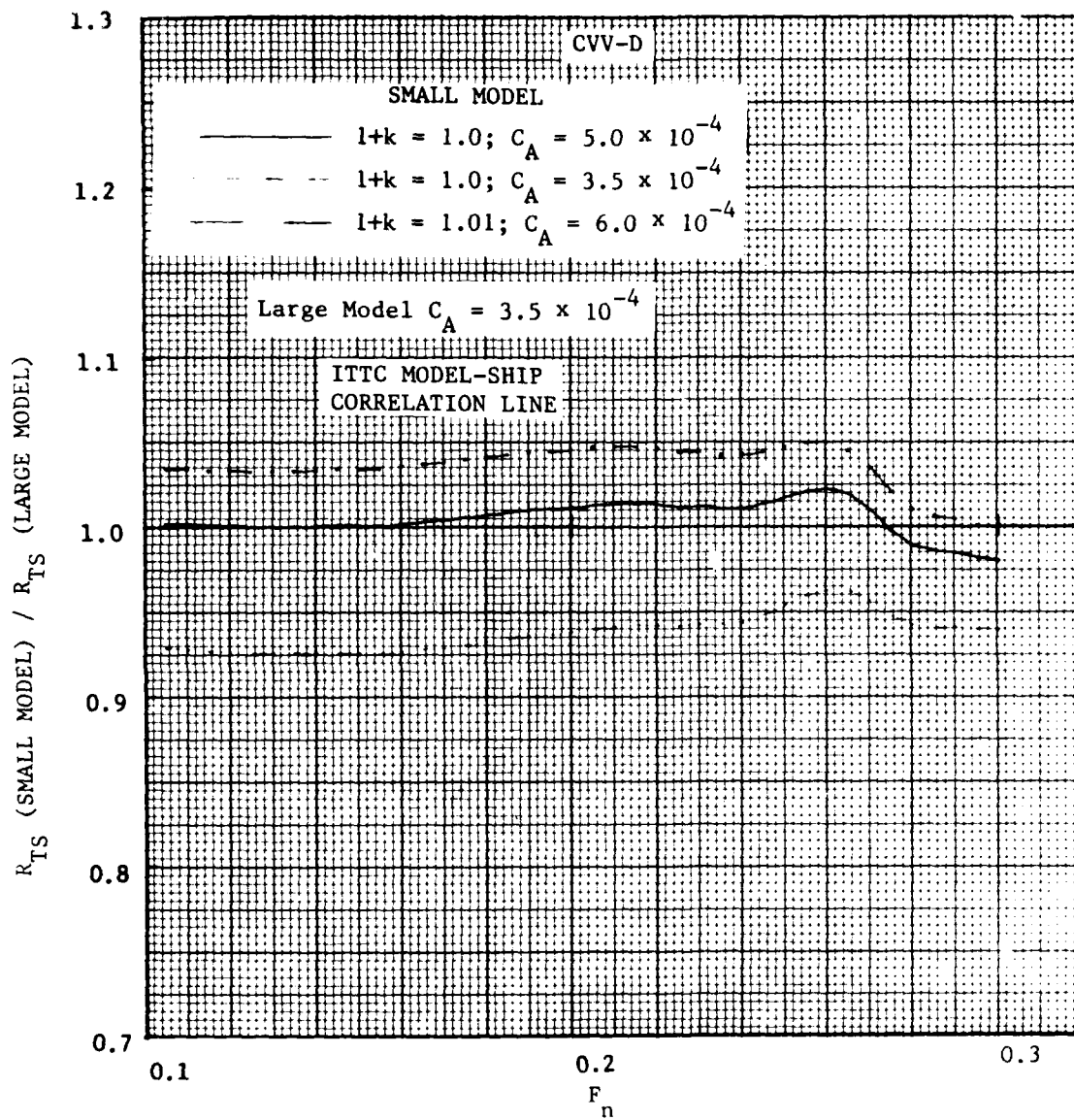


FIGURE 40 - $R_{TS} \text{ (SMALL MODEL)} / R_{TS} \text{ (LARGE MODEL)}$ FOR THE CVV-D MODELS

TABLE 1
PRINCIPAL DIMENSIONS OF SHIPS AND MODELS

	SHIP	MODEL $\lambda = 31.435$	MODEL $\lambda = 144$
CVV - B			
LENGTH	262.1 m	8.34 m (27.36 ft)	1.82 m (5.97 ft)
BEAM	38.4 m	1.22 m (4.01 ft)	0.27 m (0.88 ft)
DRAFT	10.36 m ²	0.33 m (1.08 ft)	0.072 m (0.236 ft)
WETTED SURFACE	10470 m ²	10.60 m ² (114.1 ft ²)	0.51 m ² (5.436 ft ²)
DISPLACEMENT	63430 t	1985 kg (4377 lbs)	20.7 kg (45.6 lbs)
CVV - A			
LENGTH	262.1 m	8.34 m (27.36 ft)	1.82 m (5.97 ft)
BEAM	38.4 m	1.22 m (4.01 ft)	0.27 m (0.88 ft)
DRAFT	10.36 m ²	0.33 m (1.08 ft)	0.072 m (0.236 ft)
WETTED SURFACE	10780 m ²	10.91 m ² (117.4 ft ²)	0.52 m ² (5.597 ft ²)
DISPLACEMENT	63430 t	1985 kg (4377 lbs)	20.7 kg (45.6 lbs)
CVV - D			
LENGTH	262.1 m	8.34 m (27.36 ft)	1.82 m (5.97 ft)
BEAM	38.4 m	1.22 m (4.01 ft)	0.27 m (0.88 ft)
DRAFT	10.52 m ²	0.33 m (1.10 ft)	0.073 m (0.240 ft)
WETTED SURFACE	10620 m ²	10.75 m ² (115.7 ft ²)	0.51 m ² (5.514 ft ²)
DISPLACEMENT	62970 t	1971 kg (4345 lbs)	20.5 kg (45.2 lbs)

TABLE 2 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-A MODEL WITHOUT STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

POINT	LENGTH WETTED SURFACE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M	5.97 FT	DENSITY		997.4 KG/M ³	1.9352 SLUGS/FT ³	KINEMATIC		0.9307E-6 M ² /S	1.0018E-5 FT ² /S
		0.520 M ²	5.597 FT ²	VISCOSITY							
		VS (M/S)	VS (KNOTS)	VM (M/S)	VA (FT/SEC)	RTM (N)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000	
1	0.223	11.33	22.03	0.944	3.098	1.080	0.243	4.673	0.553	4.120	
2	0.225	11.41	22.18	0.951	3.120	1.074	0.242	4.581	0.467	4.114	
3	0.286	14.52	28.22	1.210	3.969	2.008	0.452	5.292	1.372	3.920	
4	0.234	11.87	23.07	0.989	3.245	1.180	0.265	4.652	0.570	4.082	
5	0.106	5.37	10.44	0.447	1.468	0.255	0.057	4.918	0.092	4.826	
6	0.106	5.37	10.44	0.447	1.468	0.246	0.055	4.738	-0.088	4.826	
7	0.125	6.32	12.29	0.527	1.729	0.349	0.078	4.843	0.186	4.657	
8	0.145	7.35	14.28	0.612	2.009	0.461	0.104	4.740	0.230	4.508	
9	0.164	8.33	16.19	0.694	2.277	0.567	0.127	4.537	0.146	4.391	
10	0.184	9.34	18.15	0.778	2.553	0.716	0.161	4.561	0.274	4.288	
11	0.206	10.43	20.27	0.869	2.851	0.900	0.202	4.596	0.405	4.191	
12	0.224	11.38	22.11	0.948	3.110	1.065	0.239	4.570	0.453	4.117	
13	0.244	12.38	24.07	1.032	3.386	1.283	0.288	4.645	0.598	4.047	
14	0.264	13.39	26.03	1.116	3.661	1.554	0.349	4.812	0.828	3.984	
15	0.286	14.52	28.23	1.210	3.970	1.974	0.444	5.199	1.279	3.920	
16	0.306	15.49	30.12	1.291	4.236	2.348	0.528	5.431	1.561	3.870	
17	0.154	7.80	15.17	0.650	2.133	0.529	0.119	4.830	0.377	4.452	
18	0.174	8.83	17.16	0.735	2.413	0.629	0.141	4.484	0.146	4.338	
19	0.195	9.90	19.25	0.825	2.708	0.794	0.179	4.495	0.259	4.236	
20	0.214	10.87	21.14	0.906	2.973	1.009	0.227	4.738	0.583	4.155	
21	0.234	11.86	23.06	0.988	3.243	1.143	0.257	4.510	0.428	4.082	
22	0.254	12.87	25.02	1.073	3.519	1.417	0.319	4.749	0.734	4.016	
23	0.274	13.90	27.02	1.159	3.801	1.744	0.392	5.010	1.056	3.954	
24	0.296	15.02	29.20	1.252	4.107	1.943	0.437	4.782	0.888	3.894	
25	0.296	15.01	29.18	1.251	4.104	2.158	0.485	5.318	1.424	3.894	

TABLE 3 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-A MODEL WITH STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

POINT	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES											
	LENGTH		5.97 FT		DENSITY		997.4 KG/M ³		1.9352 SLUGS/FT ³			
	WETTED		5.597 FT ²		KINEVATIC		0.9307E-6 M ² /S		1.0018E-5 FT ² /S			
	SURFACE		FROUDE		VS	VS	VM	RTV	RTM	CTM	CR	CFM
NUMBER	(M, S)	(KNOTS)	(M/S)	(FT/SEC)	(N)	(LBS)	*1000	*1000	*1000	*1000		
1	0.104	5.26	10.22	0.438	1.438	0.280	0.063	5.626	0.777	4.846		
2	0.123	6.22	12.09	0.518	1.701	0.358	0.081	5.137	0.464	4.673		
3	0.143	7.26	14.11	0.605	1.984	0.464	0.104	4.893	0.371	4.521		
4	0.163	8.25	16.03	0.687	2.255	0.607	0.137	4.957	0.556	4.400		
5	0.183	9.26	18.01	0.772	2.533	0.757	0.170	4.895	0.601	4.295		
6	0.203	10.31	20.04	0.859	2.818	0.931	0.209	4.867	0.666	4.201		
7	0.225	11.39	22.14	0.949	3.114	1.108	0.249	4.745	0.629	4.116		
8	0.245	12.44	24.17	1.036	3.400	1.361	0.306	4.886	0.843	4.043		
9	0.263	13.35	25.94	1.112	3.649	1.557	0.350	4.854	0.867	3.986		
10	0.283	14.37	27.93	1.198	3.929	2.030	0.456	5.459	1.531	3.928		
11	0.304	15.39	29.92	1.283	4.208	2.404	0.540	5.635	1.760	3.875		
12	0.115	5.81	11.29	0.484	1.588	0.321	0.072	5.279	0.536	4.744		
13	0.134	6.81	13.25	0.568	1.863	0.423	0.095	5.065	0.482	4.583		
14	0.155	7.84	15.24	0.653	2.143	0.532	0.120	4.813	0.365	4.448		
15	0.174	8.83	17.17	0.736	2.415	0.691	0.155	4.920	0.583	4.337		
16	0.195	9.86	19.18	0.822	2.697	0.847	0.190	4.833	0.594	4.239		
17	0.216	10.93	21.25	0.911	2.989	1.046	0.235	4.861	0.711	4.151		
18	0.234	11.87	23.08	0.989	3.246	1.261	0.284	4.968	0.887	4.081		
19	0.254	12.89	25.05	1.074	3.523	1.501	0.337	5.020	1.005	4.015		
20	0.274	13.90	27.02	1.159	3.801	1.809	0.407	5.198	1.244	3.954		
21	0.294	14.91	28.99	1.243	4.077	2.211	0.497	5.521	1.622	3.899		
22	0.223	11.29	21.94	0.941	3.086	1.133	0.255	4.940	0.817	4.124		
23	0.264	13.40	26.05	1.117	3.664	1.625	0.365	5.026	1.043	3.983		
24	0.284	14.41	28.02	1.201	3.941	2.039	0.459	5.451	1.525	3.926		
25	0.296	15.03	29.21	1.252	4.108	2.254	0.507	5.545	1.652	3.893		

TABLE 4 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-B MODEL WITHOUT
STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

POINT	LENGTH WETTED SURFACE FROUDE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M	5.97 FT	DENSITY		997.4 KG/M ³	1.9352 SLUGS/FT ³	KINEMATIC		0.9307E-6 M ² /S	1.0018E-5 FT ² /S
		0.505 M ²	5.436 FT ²	VISCOSITY		RTM	CTM	CR		RTM	CTM
		VS (M/S)	VS (KNOTS)	VM (FT/SEC)	RTM (N)	(LBS)	*1000	CR	*1000	CFM	*1000
1	0.112	5.67	11.02	1.550	0.277	0.062	4.530	0.161	4.769	4.769	
2	0.112	5.69	11.06	1.556	0.265	0.060	4.672	-0.093	4.765	4.765	
3	0.132	6.68	12.99	1.827	0.389	0.088	4.984	0.382	4.602	4.602	
4	0.133	6.72	13.06	1.837	0.383	0.086	4.851	0.254	4.596	4.596	
5	0.152	7.72	15.00	2.110	0.467	0.105	4.484	0.021	4.462	4.462	
6	0.153	7.74	15.04	2.116	0.479	0.108	4.577	0.118	4.460	4.460	
7	0.172	8.70	16.91	2.378	0.620	0.139	4.583	0.332	4.352	4.352	
8	0.171	8.68	16.87	2.373	0.165	0.037	1.253	-3.101	4.353	4.353	
9	0.193	9.80	19.05	2.680	0.800	0.180	4.762	0.517	4.248	4.248	
10	0.212	10.76	20.92	2.942	0.915	0.206	4.520	0.356	4.164	4.164	
11	0.233	11.81	22.95	3.228	1.112	0.250	4.560	0.473	4.086	4.086	
12	0.252	12.80	24.88	3.499	1.298	0.292	4.533	0.513	4.020	4.020	
13	0.275	13.92	27.06	3.806	1.675	0.377	4.943	0.990	3.953	3.953	
14	0.295	14.96	29.08	4.090	2.158	0.485	5.513	1.616	3.897	3.897	
15	0.102	5.18	10.06	1.415	0.215	0.048	4.586	-0.279	4.866	4.866	
16	0.103	5.22	10.15	1.428	0.215	0.048	4.503	-0.353	4.856	4.856	
17	0.123	6.22	12.09	1.701	0.299	0.067	4.416	-0.258	4.673	4.673	
18	0.123	6.25	12.14	1.708	0.293	0.066	4.288	-0.381	4.669	4.669	
19	0.143	7.23	14.05	1.976	0.433	0.097	4.738	0.213	4.525	4.525	
20	0.143	7.25	14.10	1.993	0.448	0.101	4.873	0.352	4.522	4.522	
21	0.162	8.19	15.93	2.240	0.536	0.120	4.562	0.156	4.406	4.406	
22	0.162	8.21	15.96	2.245	0.501	0.113	4.251	-0.153	4.404	4.404	
23	0.182	9.24	17.95	2.525	0.750	0.169	5.031	0.733	4.297	4.297	
24	0.182	9.24	17.97	2.527	0.644	0.156	4.647	0.351	4.297	4.297	
25	0.203	10.28	19.98	2.810	0.819	0.195	4.702	0.499	4.203	4.203	
26	0.223	11.28	21.93	3.095	1.012	0.228	4.545	0.421	4.124	4.124	
27	0.242	12.29	23.89	3.380	1.149	0.267	4.503	0.450	4.053	4.053	
28	0.264	13.41	26.06	3.665	1.448	0.335	4.736	0.753	3.983	3.983	
29	0.285	14.44	28.07	3.948	1.936	0.438	5.336	1.412	3.924	3.924	
30	0.305	15.46	30.05	4.227	2.373	0.533	5.676	1.804	3.872	3.872	
31	0.203	10.27	19.97	2.809	0.844	0.190	4.571	0.421	4.204	4.204	
32	0.162	8.23	15.99	2.244	0.542	0.131	4.920	0.517	4.403	4.403	
33	0.163	8.25	16.03	2.255	0.504	0.127	4.737	0.337	4.400	4.400	
34	0.265	13.42	26.09	3.664	1.538	0.346	4.884	0.902	3.982	3.982	
35	0.286	14.48	28.15	3.960	1.940	0.445	5.397	1.476	3.922	3.922	
36	0.255	12.91	25.09	3.523	1.314	0.295	4.510	0.496	4.013	4.013	

TABLE 5 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-B MODEL WITH
STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

POINT	LENGTH WETTED SURFACE FROUDE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M	5.97 FT	DENSITY		997.4 KG/M ³	1.9352 SLUGS/FT ³	KINEMATIC		0.9307E-6 M ² /S	1.0018E-5 FT ² /S
		0.505 M ²	5.436 FT ²	VISCOSITY		RTM	CTM	RTM		CTM	CR
		VS (M/S)	VS (KNOTS)	VM (FT/SEC)	RTM (N)	RTM (LBS)	CTM (LBS)	RTM (LBS)	CTM (LBS)	CR	CFM *1000
1	0.104	5.27	10.24	0.439	1.440	0.052	0.052	0.052	4.749	-0.098	4.847
2	0.125	6.36	12.36	0.530	1.738	0.077	0.077	0.077	4.846	0.195	4.652
3	0.146	7.38	14.35	0.615	2.018	0.107	0.107	0.107	5.000	0.495	4.505
4	0.166	8.41	16.35	0.701	2.300	0.132	0.132	0.132	4.755	0.373	4.382
5	0.185	9.39	18.25	0.782	2.567	0.167	0.167	0.167	4.827	0.544	4.283
6	0.206	10.43	20.27	0.869	2.851	0.204	0.204	0.204	4.781	0.590	4.191
7	0.225	11.43	22.22	0.953	3.125	0.247	0.247	0.247	4.811	0.697	4.113
8	0.246	12.46	24.22	1.038	3.407	0.290	0.290	0.290	4.747	0.705	4.042
9	0.265	13.45	26.14	1.121	3.677	0.347	0.347	0.347	4.872	0.892	3.980
10	0.285	14.47	28.13	1.206	3.957	0.463	0.463	0.463	5.627	1.704	3.922
11	0.303	15.36	29.86	1.280	4.200	0.546	0.546	0.546	5.885	2.008	3.876
12	0.116	5.87	11.41	0.489	1.605	0.067	0.067	0.067	4.960	0.227	4.733
13	0.136	6.89	13.40	0.575	1.885	0.093	0.093	0.093	4.981	0.410	4.571
14	0.156	7.92	15.39	0.660	2.164	0.123	0.123	0.123	4.973	0.535	4.439
15	0.176	8.92	17.33	0.743	2.438	0.156	0.156	0.156	4.993	0.664	4.329
16	0.196	9.95	19.34	0.829	2.720	0.190	0.190	0.190	4.875	0.643	4.232
17	0.216	10.97	21.32	0.914	2.998	0.228	0.228	0.228	4.827	0.679	4.148
18	0.236	11.96	23.25	0.997	3.270	0.272	0.272	0.272	4.829	0.754	4.075
19	0.256	12.98	25.24	1.082	3.550	0.322	0.322	0.322	4.858	0.849	4.008
20	0.278	14.08	27.37	1.173	3.850	0.413	0.413	0.413	5.297	1.353	3.944
21	0.295	14.97	29.09	1.247	4.092	0.515	0.515	0.515	5.850	1.953	3.896
22	0.266	13.49	26.23	1.124	3.689	0.365	0.365	0.365	5.095	1.117	3.978

TABLE 5 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-3 MODEL WITHOUT STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

POINT	LENGTH WETTED SURFACE FROUDE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M		5.97 FT		DENSITY		997.4 KG/M ³		1.9352 SLUGS/FT ³	
		0.512 M ⁻²		5.514 FT ⁻²		KINEMATIC		0.9307E-6 M ² /S		1.0018E-5 FT ² /S	
		VS (M/S)	VS (KNOTS)	VM (M/S)	VM (FT/SEC)	RTM (N)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000	
1	0.103	5.23	10.17	0.436	1.431	0.215	0.048	4.421	-0.433	4.854	
2	0.123	6.21	12.08	0.518	1.699	0.321	0.072	4.682	0.007	4.675	
3	0.143	7.27	14.13	0.606	1.987	0.423	0.095	4.519	0.000	4.520	
4	0.163	8.26	16.06	0.689	2.259	0.520	0.117	4.294	-0.105	4.399	
5	0.183	9.28	18.03	0.773	2.536	0.663	0.149	4.345	0.052	4.294	
6	0.203	10.31	20.04	0.859	2.818	0.797	0.179	4.230	0.029	4.201	
7	0.225	11.39	22.14	0.949	3.114	0.956	0.215	4.154	0.038	4.116	
8	0.245	12.41	24.12	1.034	3.392	1.168	0.263	4.276	0.231	4.045	
9	0.263	13.35	25.96	1.113	3.651	1.485	0.334	4.695	0.709	3.988	
10	0.284	14.38	27.96	1.198	3.932	1.974	0.444	5.360	1.453	3.927	
11	0.306	15.51	30.15	1.292	4.240	2.404	0.540	5.634	1.765	3.869	
12	0.315	5.81	11.29	0.484	1.588	0.290	0.065	4.839	0.095	4.744	
13	0.134	6.82	13.25	0.568	1.864	0.392	0.088	4.758	0.176	4.582	
14	0.154	7.83	15.22	0.652	2.140	0.476	0.107	4.383	-0.066	4.449	
15	0.174	8.80	17.11	0.734	2.407	0.588	0.132	4.280	-0.060	4.341	
16	0.194	9.82	19.09	0.818	2.685	0.735	0.165	4.295	0.052	4.243	
17	0.214	10.86	21.11	0.905	2.969	0.872	0.196	4.167	0.011	4.156	
18	0.235	11.92	23.18	0.994	3.260	1.087	0.244	4.308	0.231	4.078	
19	0.254	12.86	24.99	1.071	3.515	1.323	0.298	4.513	0.497	4.016	
20	0.274	13.89	27.00	1.157	3.797	1.737	0.391	5.078	1.123	3.955	
21	0.293	14.88	28.92	1.240	4.068	2.232	0.502	5.685	1.783	3.901	
22	0.244	12.37	24.04	1.031	3.381	1.183	0.266	4.361	0.313	4.048	
23	0.284	14.40	27.98	1.200	3.936	1.990	0.447	5.412	1.485	3.927	
24	0.306	15.51	30.15	1.292	4.240	2.404	0.540	5.634	1.765	3.869	
25	0.234	11.85	23.04	0.988	3.241	1.093	0.246	4.384	0.301	4.083	
26	0.225	11.40	22.17	0.950	3.118	0.950	0.214	4.116	0.001	4.115	

TABLE 7 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-D MODEL WITH
STUDS FROM THE 140 FOOT BASIN EXPERIMENTS

POINT	LENGTH WETTED SURFACE FOUNDE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M	5.97 FT	DENSITY		KINEMATIC		RTM		CR	CFM
		0.512 M ⁻²	5.514 FT ⁻²	997.4 KG/M ⁻³	0.9307E-6 M ² /S	1.0018E-5 FT ² /S	0.9307E-6 M ² /S	1.0018E-5 FT ² /S	1.9352 SLUGS/FT ⁻³		
		VS (M/S)	VS (KNOTS)	VM (M/S)	VM (FT/SEC)	RTM (N)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000	
1	0.105	5.34	10.37	0.445	1.459	0.252	0.057	4.992	0.160	4.833	
2	0.124	6.29	12.23	0.524	1.720	0.346	0.078	4.923	0.261	4.662	
3	0.145	7.34	14.27	0.612	2.007	0.461	0.104	4.821	0.310	4.510	
4	0.164	8.30	16.13	0.691	2.268	0.567	0.127	4.642	0.247	4.395	
5	0.183	9.30	18.07	0.775	2.542	0.719	0.162	4.690	0.399	4.291	
6	0.196	9.95	19.33	0.829	2.719	0.816	0.183	4.650	0.418	4.232	
7	0.225	11.42	22.20	0.952	3.122	1.062	0.239	4.590	0.476	4.114	
8	0.236	11.99	23.30	0.999	3.277	1.193	0.268	4.679	0.606	4.074	
9	0.253	12.84	24.96	1.076	3.510	1.426	0.321	4.877	0.868	4.018	
10	0.273	13.87	26.95	1.155	3.791	1.812	0.407	5.313	1.357	3.956	
11	0.293	14.85	28.87	1.238	4.061	2.282	0.513	5.831	1.929	3.902	
12	0.115	5.85	11.37	0.487	1.599	0.302	0.068	4.977	0.241	4.737	
13	0.135	6.83	13.27	0.569	1.866	0.392	0.088	4.748	0.167	4.581	
14	0.154	7.81	15.19	0.651	2.136	0.529	0.119	4.889	0.438	4.451	
15	0.174	8.80	17.10	0.733	2.405	0.654	0.147	4.763	0.422	4.341	
16	0.204	10.36	20.14	0.863	2.833	0.887	0.200	4.659	0.463	4.196	
17	0.216	10.97	21.33	0.914	3.000	0.996	0.224	4.665	0.517	4.147	
18	0.244	12.38	24.07	1.032	3.385	1.286	0.289	4.729	0.682	4.047	
19	0.264	13.38	26.01	1.115	3.659	1.610	0.362	5.066	1.082	3.984	
20	0.283	14.35	27.90	1.196	3.924	2.061	0.463	5.641	1.712	3.929	
21	0.305	15.47	30.07	1.289	4.229	2.541	0.571	5.986	2.115	3.871	
22	0.154	7.82	15.19	0.651	2.137	0.508	0.114	4.683	0.232	4.450	
23	0.226	11.47	22.30	0.956	3.136	1.096	0.246	4.696	0.586	4.110	
24	0.236	11.96	23.24	0.996	3.269	1.180	0.265	4.653	0.577	4.076	

LENGTH 8.339 M 27.36 FT DENSITY 997.4 KG/M³ 1.9352 SLUGS/FT³
 WETTED SURFACE 10.907 M² 117.400 FT² KINEMATIC 0.9307E-6 M²/S 1.0018E-5 FT²/S
 POINT

POINT	FRONDE NUMBER	VS (M/S)	VS (KNOTS)	VA (M/S)	VM (FT/SEC)	RTM (IN)	RTM (LBS)	CTM	CR	CFM
1	0.103	5.24	10.19	0.935	3.069	15.771	3.546	3.314	0.220	3.094
2	0.103	5.24	10.19	0.935	3.069	16.212	3.645	3.406	0.312	3.094
3	0.123	6.23	12.11	1.111	3.645	21.850	4.912	3.255	0.252	3.002
4	0.123	6.23	12.11	1.111	3.645	22.643	5.091	3.373	0.371	3.002
5	0.143	7.27	14.13	1.297	4.254	29.339	6.596	3.209	0.285	2.923
6	0.143	7.27	14.14	1.297	4.256	29.668	6.715	3.263	0.340	2.923
7	0.164	8.30	16.13	1.480	4.855	38.150	8.577	3.203	0.345	2.858
8	0.164	8.30	16.13	1.480	4.855	38.414	8.636	3.225	0.367	2.858
9	0.183	9.29	18.06	1.657	5.436	48.194	10.835	3.228	0.424	2.804
10	0.183	9.29	18.06	1.657	5.436	48.811	10.974	3.269	0.465	2.804
11	0.205	10.38	20.17	1.851	6.073	61.850	13.905	3.319	0.566	2.753
12	0.205	10.37	20.17	1.850	6.071	61.057	13.727	3.279	0.526	2.753
13	0.225	11.40	22.17	2.034	6.673	75.683	17.015	3.364	0.654	2.710
14	0.225	11.40	22.16	2.033	6.671	75.331	16.936	3.350	0.640	2.710
15	0.245	12.43	24.16	2.217	7.274	91.806	20.640	3.459	0.787	2.672
16	0.245	12.43	24.16	2.217	7.274	91.450	20.571	3.434	0.762	2.672
17	0.266	13.50	26.23	2.407	7.897	114.450	25.731	3.632	0.996	2.636
18	0.266	13.50	26.23	2.407	7.897	114.185	25.671	3.624	0.987	2.636
19	0.266	13.50	26.23	2.407	7.897	115.419	25.948	3.663	1.027	2.636
20	0.285	14.46	28.10	2.578	8.459	146.785	33.000	4.060	1.453	2.607
21	0.285	14.46	28.10	2.578	8.459	146.696	32.980	4.056	1.449	2.607
22	0.285	14.46	28.10	2.578	8.459	146.785	33.000	4.060	1.453	2.607
23	0.306	15.49	30.11	2.763	9.064	179.912	40.448	4.334	1.756	2.578
24	0.306	15.49	30.10	2.762	9.062	180.089	40.488	4.340	1.762	2.578
25	0.113	5.72	11.12	1.020	3.346	19.471	4.378	3.442	0.394	3.048
26	0.113	5.72	11.12	1.020	3.346	18.590	4.179	3.286	0.239	3.048
27	0.133	6.76	13.13	1.205	3.954	26.256	5.903	3.324	0.363	2.960
28	0.133	6.76	13.14	1.205	3.955	26.696	6.002	3.378	0.417	2.960
29	0.154	7.79	15.15	1.390	4.560	33.921	7.626	3.229	0.340	2.889
30	0.154	7.79	15.15	1.390	4.560	34.802	7.824	3.312	0.424	2.889
31	0.173	8.79	17.08	1.567	5.141	43.436	9.765	3.253	0.422	2.831
32	0.173	8.79	17.07	1.566	5.139	43.612	9.805	3.268	0.437	2.831
33	0.194	9.85	19.14	1.756	5.761	55.859	12.558	3.331	0.554	2.777
34	0.194	9.84	19.13	1.755	5.759	55.947	12.578	3.339	0.561	2.777
35	0.214	10.87	21.12	1.938	6.358	68.899	15.490	3.373	0.641	2.732
36	0.214	10.87	21.12	1.938	6.358	68.723	15.450	3.365	0.633	2.732
37	0.235	11.92	23.18	2.127	6.978	84.758	19.055	3.445	0.755	2.690
38	0.235	11.92	23.18	2.127	6.977	85.022	19.115	3.457	0.766	2.690
39	0.235	11.92	23.18	2.127	6.978	84.317	18.956	3.427	0.737	2.690
40	0.256	12.96	25.19	2.311	7.581	102.115	22.957	3.515	0.861	2.654
41	0.256	12.96	25.18	2.311	7.581	101.586	22.839	3.498	0.844	2.654
42	0.275	13.96	27.13	2.489	8.166	129.340	29.078	3.839	1.217	2.622
43	0.275	13.96	27.13	2.489	8.166	129.868	29.197	3.854	1.232	2.622
44	0.194	9.84	19.13	1.755	5.759	55.771	12.538	3.328	0.551	2.777
45	0.194	9.84	19.12	1.755	5.757	55.947	12.578	3.341	0.563	2.777

TABLE 6 - UNPAIRED RELATIONSHIP DATA FOR THE LARGE CV7-A MODEL
(CONTINUED)

LENGTH		PTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES		CR, CFM VALUES		CR, CFM VALUES	
WEIGHT		CR		CFM		CR	
SURFACE		PT-2		PT-3		PT-4	
POINT	NUMBER	CR	CFM	CR	CFM	CR	CFM
46	0.235	11.91	23.16	2.125	6.972	84.758	19.055
47	0.235	11.91	23.16	2.125	6.972	85.022	19.115
48	0.235	14.98	29.11	2.671	8.763	167.049	37.556
49	0.235	14.98	29.11	2.671	8.763	164.934	37.081
50	0.183	9.28	18.04	1.655	5.431	49.692	11.172

POINT	PROUDE NUMBER	LENGTH		VS (KNOTS)		VT (M/SEC)		VM (FT/SEC)		RTM (N)	RTM (LBS)	CTM		CR	CFM
		8.339 FT	10.597 FT	27.36 FT	114.070 FT	27.36 FT	114.070 FT	27.36 FT	114.070 FT			1000	1000		
1970 MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES															
DENSITY 997.4 KG/M ³ 1.9352 SLUGS FT ³															
KINEMATIC VISCOSITY 0.9307E-6 M ² /S 1.0018E-5 FT ² /S															
1	0.103	5.23	10.17	0.933	3.092	16.388	3.684	3.560	0.405	3.095					3.095
2	0.103	5.23	10.16	0.933	3.090	15.419	3.466	3.354	0.258	3.096					3.096
3	0.122	6.21	12.07	1.108	3.634	21.762	4.893	3.357	0.353	3.004					3.004
4	0.123	6.21	12.08	1.108	3.636	22.203	4.992	3.421	0.417	3.004					3.004
5	0.143	7.25	14.09	1.293	4.242	30.220	6.794	3.421	0.496	2.925					2.925
6	0.143	7.25	14.09	1.293	4.242	28.987	6.517	3.281	0.356	2.925					2.925
7	0.143	7.25	14.09	1.293	4.242	28.811	6.477	3.261	0.336	2.925					2.925
8	0.163	8.27	16.08	1.476	4.842	37.974	8.537	3.299	0.440	2.860					2.860
9	0.163	8.27	16.08	1.476	4.842	38.326	8.616	3.330	0.470	2.860					2.860
10	0.183	9.27	18.02	1.654	5.425	45.903	10.320	3.177	0.372	2.805					2.805
11	0.183	9.27	18.02	1.654	5.426	45.931	10.340	3.182	0.377	2.805					2.805
12	0.204	10.36	20.13	1.847	6.060	57.885	13.014	3.211	0.457	2.754					2.754
13	0.204	10.36	20.13	1.847	6.060	58.150	13.073	3.225	0.472	2.754					2.754
14	0.225	11.38	22.13	2.030	6.661	64.956	15.728	3.212	0.501	2.711					2.711
15	0.225	11.38	22.13	2.030	6.661	70.573	15.866	3.240	0.529	2.711					2.711
16	0.225	11.38	22.13	2.030	6.651	64.516	15.629	3.191	0.480	2.711					2.711
17	0.245	12.41	24.12	2.213	7.262	85.022	19.115	3.284	0.611	2.673					2.673
18	0.245	12.41	24.12	2.213	7.262	84.317	18.956	3.257	0.584	2.673					2.673
19	0.266	13.47	26.18	2.402	7.882	110.221	24.780	3.614	0.977	2.637					2.637
20	0.266	13.47	26.19	2.403	7.984	111.278	25.018	3.647	1.010	2.637					2.637
21	0.285	14.45	28.09	2.577	8.456	145.815	32.782	4.154	1.547	2.607					2.607
22	0.285	14.45	28.09	2.577	8.456	146.168	32.861	4.164	1.557	2.607					2.607
23	0.285	14.45	28.08	2.577	8.454	135.344	32.901	4.171	1.564	2.607					2.607
24	0.163	8.28	16.09	1.476	4.844	37.269	8.379	3.235	0.376	2.859					2.859
25	0.163	8.28	16.09	1.476	4.844	36.052	8.557	3.304	0.445	2.859					2.859
26	0.305	15.47	30.07	2.759	9.052	185.815	41.775	4.619	2.040	2.579					2.579
27	0.305	15.47	30.07	2.759	9.052	185.873	42.013	4.645	2.067	2.579					2.579
28	0.113	5.71	11.10	1.018	3.341	19.031	4.279	3.473	0.424	3.048					3.048
29	0.113	5.71	11.09	1.018	3.339	19.207	4.318	3.509	0.460	3.049					3.049
30	0.133	6.75	13.12	1.204	3.949	25.110	5.645	3.240	0.319	2.961					2.961
31	0.133	6.75	13.12	1.204	3.949	24.846	5.586	3.245	0.284	2.961					2.961
32	0.153	7.79	15.11	1.387	4.550	33.040	7.428	3.251	0.361	2.890					2.890
33	0.153	7.77	15.11	1.385	4.548	34.626	7.785	3.410	0.520	2.890					2.890
34	0.173	8.77	17.04	1.563	5.129	42.946	9.666	3.329	0.497	2.832					2.832
35	0.173	8.77	17.04	1.563	5.129	42.820	9.627	3.315	0.484	2.832					2.832
36	0.194	9.83	19.11	1.754	5.754	51.355	11.548	3.160	0.382	2.778					2.778
37	0.194	9.83	19.11	1.754	5.754	52.804	11.885	3.252	0.475	2.778					2.778
38	0.214	10.86	21.10	1.936	6.352	63.172	14.202	3.168	0.456	2.732					2.732
39	0.214	10.86	21.10	1.936	6.352	61.908	14.143	3.176	0.443	2.732					2.732
40	0.235	11.91	23.16	2.124	6.970	77.357	17.391	3.242	0.551	2.691					2.691
41	0.235	11.91	23.15	2.124	6.970	77.357	17.391	3.243	0.553	2.691					2.691
42	0.255	12.94	25.16	2.309	7.574	96.455	21.690	3.426	0.771	2.654					2.654
43	0.255	12.94	25.17	2.309	7.574	96.455	21.690	3.426	0.771	2.654					2.654
44	0.275	13.94	27.11	2.497	8.190	127.225	28.603	3.842	1.270	2.622					2.622
45	0.275	13.94	27.10	2.497	8.190	127.225	28.741	3.812	1.289	2.622					2.622

TABLE 9 - UNFAIRED RESISTANCE DATA FOR THE LARGE CVV-8 MODEL
(CONTINUED)

ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES											
LENGTH		8.339	M	27.36	FT	DENSITY		997.4 KG/M ³		1.9352 SLUGS/FT ³	
WETTED SURFACE		10.597	M ²	114.070	FT ²	KINEMATIC VISCOSITY		0.9307E-6 M ² /S		1.0018E-5 FT ² /S	
POINT	FROUDE NUMBER	VS	VS	VM	VM	RTM	RTM	CTM	CR	CFM	
		(M/S)	(KNOTS)	(M/S)	(FT/SEC)	(N)	(LBS)	*1000	*1000	*1000	
46	0.275	13.95	27.11	2.438	8.162	125.992	28.325	3.852	1.230	2.622	
47	0.245	12.41	24.12	2.213	7.262	86.961	19.550	3.359	0.686	2.573	
48	0.245	12.42	24.13	2.214	7.265	89.696	19.491	3.346	0.673	2.672	
49	0.245	12.43	24.12	2.213	7.262	85.903	19.313	3.318	0.645	2.673	
50	0.295	14.97	29.09	2.609	8.757	168.723	37.932	4.482	1.889	2.592	
51	0.295	14.95	29.08	2.608	8.753	167.137	37.576	4.444	1.851	2.593	
52	0.173	8.77	17.05	1.584	5.132	42.467	9.547	3.284	0.453	2.832	
53	0.173	8.77	17.04	1.584	5.131	41.850	9.409	3.238	0.406	2.832	
54	0.173	8.77	17.05	1.584	5.132	40.705	9.151	3.148	0.317	2.832	
55	0.214	10.85	21.09	1.935	6.350	63.673	14.301	3.213	0.481	2.732	
56	0.214	10.85	21.09	1.935	6.350	64.053	14.400	3.236	0.503	2.732	
57	0.214	10.85	21.09	1.935	6.350	65.022	14.618	3.285	0.552	2.732	
58	0.214	10.85	21.10	1.936	6.353	63.789	14.341	3.219	0.487	2.732	

TABLE 10. REQUIRED RESISTANCE DATA FOR THE LARGE CAV-D MODEL

POINT	LENGTH WEETED SURFACE PROUDE NUMBER	1"TC MODEL-SHIP CORRELATION LINE USED FOR CR. CFM VALUES									
		8.339 M ² 27.36 FT		DENSITY 997.4 KG/M ³		KINEMATIC 0.9307E-6 M ² /S		1.9352 SLUGS/FT ³		1.0018E-5 FT ² /S	
		VS (M/S)	VS (KNOTS)	V1 (M/S)	μM (FT/SEC)	R1M (IN)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000	
1	0.103	5.24	10.18	0.934	3.065	14.273	3.209	3.051	-0.044	3.095	
2	0.103	5.24	10.18	0.934	3.065	14.537	3.268	3.108	0.013	3.095	
3	0.123	6.22	12.09	1.109	3.639	20.264	4.556	3.073	0.070	3.003	
4	0.123	6.22	12.09	1.109	3.638	21.145	4.754	3.208	0.205	3.003	
5	0.143	7.26	14.10	1.294	4.246	28.018	6.299	3.121	0.197	2.924	
6	0.143	7.26	14.10	1.294	4.246	27.930	6.279	3.111	0.187	2.924	
7	0.163	8.28	16.09	1.477	4.845	35.947	8.082	3.075	0.216	2.859	
8	0.163	8.28	16.09	1.477	4.845	30.123	8.121	3.009	0.211	2.859	
9	0.183	9.27	18.02	1.654	5.426	45.727	10.280	3.119	0.314	2.805	
10	0.183	9.27	18.02	1.654	5.426	45.903	10.320	3.126	0.322	2.805	
11	0.204	10.36	20.14	1.848	6.063	56.828	12.776	3.105	0.351	2.754	
12	0.204	10.36	20.14	1.848	6.063	55.947	12.578	3.056	0.303	2.754	
13	0.225	11.38	22.13	2.031	6.662	70.661	15.886	3.197	0.466	2.711	
14	0.225	11.38	22.14	2.031	6.664	70.220	15.787	3.175	0.465	2.711	
15	0.245	12.42	24.13	2.214	7.265	86.696	19.491	3.299	0.526	2.672	
16	0.245	12.42	24.13	2.214	7.265	86.432	19.432	3.289	0.516	2.672	
17	0.266	13.48	26.20	2.404	7.887	113.304	25.473	3.658	1.021	2.637	
18	0.266	13.48	26.20	2.404	7.887	113.481	25.513	3.664	1.027	2.637	
19	0.285	14.45	28.08	2.576	8.453	154.274	34.684	4.336	1.729	2.607	
20	0.285	14.45	28.08	2.577	8.454	153.745	34.565	4.320	1.713	2.607	
21	0.305	15.47	30.08	2.760	9.054	191.983	43.162	4.703	2.125	2.579	
22	0.305	15.48	30.08	2.760	9.056	191.933	43.162	4.701	2.123	2.578	
23	0.113	5.71	11.10	1.018	3.341	17.269	3.882	3.107	0.052	3.048	
24	0.113	5.71	11.09	1.018	3.339	17.533	3.942	3.158	0.109	3.049	
25	0.133	6.75	13.12	1.204	3.950	23.877	5.368	3.073	0.112	2.961	
26	0.133	6.75	13.12	1.204	3.949	24.934	5.606	3.211	0.250	2.961	
27	0.153	7.78	15.11	1.387	4.550	31.806	7.151	3.085	0.195	2.890	
28	0.153	7.78	15.11	1.387	4.550	31.630	7.111	3.068	0.178	2.890	
29	0.173	8.77	17.05	1.564	5.132	41.057	9.231	3.131	0.299	2.832	
30	0.173	8.77	17.05	1.564	5.132	40.831	9.191	3.117	0.286	2.832	
31	0.194	9.84	19.12	1.755	5.757	50.749	11.409	3.075	0.298	2.777	
32	0.194	9.84	19.12	1.755	5.757	51.542	11.588	3.123	0.346	2.777	
33	0.214	10.86	21.11	1.937	6.355	62.027	13.945	3.084	0.352	2.732	
34	0.214	10.86	21.11	1.937	6.355	62.731	14.103	3.119	0.387	2.732	
35	0.235	11.92	23.16	2.125	6.973	77.181	17.352	3.188	0.497	2.691	
36	0.235	11.92	23.16	2.125	6.973	77.974	17.530	3.220	0.530	2.691	
37	0.255	12.95	25.17	2.310	7.578	97.974	22.026	3.426	0.772	2.654	
38	0.256	12.96	25.18	2.311	7.581	97.798	21.987	3.417	0.763	2.654	
39	0.275	13.95	27.11	2.488	8.162	132.159	29.712	3.984	1.362	2.622	
40	0.275	13.95	27.11	2.488	8.162	132.776	29.851	4.003	1.380	2.622	
41	0.225	11.92	23.13	2.030	6.971	77.024	15.747	3.170	0.492	2.711	
42	0.225	11.92	23.13	2.030	6.971	77.024	15.645	3.210	0.489	2.711	
43	0.225	11.92	23.13	2.031	6.972	77.024	15.565	3.219	0.502	2.711	
44	0.205	10.86	22.12	1.937	6.354	62.024	39.141	4.591	1.959	2.592	
45	0.205	10.86	22.11	1.937	6.354	62.024	39.458	4.590	1.946	2.592	
46	0.205	10.86	22.11	1.937	6.354	62.024	39.458	4.590	1.937	2.592	

TABLE 11 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-B MODEL WITHOUT STUDS FROM THE DLSIT EXPERIMENTS

POINT	LENGTH WETTED SURFACE FROUDE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M 0.505 M ^{1/2}	VS (M/S)	VS (KNOTS)	V ² (M ² /S ²)	FW (FT/SEC)	RTM (IN)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000
1	0.061	3.08		5.99	0.237	0.843	0.071	0.016	4.278	-1.282	5.560
2	0.071	3.60		7.00	0.300	0.984	0.083	0.020	3.924	-1.437	5.362
3	0.081	4.11		8.00	0.343	1.125	0.125	0.028	4.203	-0.996	5.199
4	0.091	4.63		8.99	0.386	1.265	0.142	0.032	3.799	-1.263	5.062
5	0.101	5.14		10.00	0.429	1.406	0.214	0.048	4.613	-0.330	4.944
6	0.112	5.65		10.99	0.471	1.546	0.245	0.055	4.372	-0.469	4.841
7	0.122	6.17		11.99	0.514	1.687	0.316	0.071	4.740	-0.009	4.749
8	0.132	6.68		12.99	0.557	1.827	0.360	0.081	4.610	-0.057	4.687
9	0.142	7.19		13.99	0.600	1.967	0.431	0.097	4.763	0.170	4.593
10	0.142	7.20		14.00	0.600	1.969	0.405	0.091	4.459	-0.133	4.592
11	0.152	7.71		14.99	0.643	2.108	0.489	0.110	4.703	0.178	4.526
12	0.162	8.23		15.00	0.686	2.250	0.538	0.121	4.541	0.078	4.463
13	0.172	8.74		15.99	0.728	2.389	0.614	0.138	4.594	0.187	4.407
14	0.182	9.25		17.98	0.771	2.529	0.685	0.154	4.575	0.220	4.355
15	0.193	9.77		18.99	0.814	2.671	0.796	0.179	4.767	0.462	4.305
16	0.203	10.28		19.98	0.856	2.810	0.867	0.195	4.692	0.432	4.260
17	0.203	10.29		19.99	0.857	2.812	0.845	0.190	4.565	0.306	4.260
18	0.213	10.80		21.00	0.900	2.953	0.943	0.212	4.619	0.402	4.217
19	0.223	11.31		21.99	0.943	3.093	1.027	0.231	4.588	0.411	4.177
20	0.233	11.83		23.00	0.986	3.235	1.116	0.251	4.557	0.418	4.139
21	0.243	12.34		23.99	1.028	3.374	1.228	0.276	4.606	0.503	4.103
22	0.254	12.86		24.99	1.071	3.515	1.339	0.301	4.629	0.559	4.070
23	0.263	13.36		25.97	1.113	3.652	1.499	0.337	4.801	0.762	4.038
24	0.274	13.89		27.00	1.157	3.797	1.695	0.381	5.021	1.014	4.007
25	0.284	14.39		27.97	1.199	3.934	1.930	0.434	5.328	1.350	3.978

TABLE 12 - APPARENT RESISTANCE DATA FOR THE SMALL CVV-B MODEL WITH STUDS FROM THE S.A.T. EXPERIMENTS

POINT	FRCODE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M		5.97 FT		998.0 KG/M ³		1.9365 SLUGS/FT ³			
		WEIGHTED		SURFACE		DENSITY		VISCOSITY			
		VS (M/S)	VS (KNOTS)	V _T (M/S)	VM (FT/SEC)	RTM (N)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000	
1	0.061	3.08	5.99	0.257	0.843	0.071	0.016	4.278	-1.282	5.560	
2	0.071	3.60	7.00	0.300	0.984	0.107	0.024	4.709	-0.652	5.362	
3	0.081	4.11	8.00	0.343	1.125	0.129	0.029	4.353	-0.845	5.199	
4	0.091	4.63	8.99	0.386	1.265	0.178	0.040	4.749	-0.313	5.062	
5	0.101	5.14	10.00	0.429	1.406	0.227	0.051	4.902	-0.042	4.944	
6	0.112	5.65	10.99	0.471	1.546	0.271	0.061	4.849	0.008	4.841	
7	0.122	6.17	11.99	0.514	1.686	0.338	0.076	5.080	0.330	4.749	
8	0.122	6.17	11.99	0.514	1.687	0.316	0.071	4.740	-0.009	4.749	
9	0.132	6.69	13.00	0.557	1.828	0.378	0.085	4.833	0.166	4.686	
10	0.142	7.19	13.99	0.600	1.967	0.436	0.098	4.812	0.219	4.593	
11	0.152	7.71	14.99	0.643	2.108	0.641	0.144	6.157	1.631	4.526	
12	0.162	8.23	15.99	0.685	2.249	0.578	0.130	4.883	0.419	4.464	
13	0.172	8.74	16.99	0.728	2.390	0.645	0.145	4.823	0.416	4.407	
14	0.183	9.25	17.99	0.771	2.530	0.738	0.166	4.927	0.573	4.354	
15	0.193	9.76	18.98	0.814	2.669	0.801	0.180	4.801	0.495	4.306	
16	0.193	9.77	19.00	0.814	2.672	0.814	0.183	4.870	0.565	4.305	
17	0.203	10.30	20.01	0.858	2.815	0.903	0.203	4.857	0.608	4.259	
18	0.213	10.80	20.99	0.900	2.952	0.983	0.221	4.818	0.601	4.217	
19	0.223	11.31	21.98	0.942	3.092	1.081	0.243	4.829	0.652	4.177	
20	0.233	11.83	22.99	0.985	3.233	1.183	0.266	4.835	0.696	4.139	
21	0.243	12.34	23.99	1.028	3.374	1.281	0.288	4.807	0.703	4.103	
22	0.253	12.85	24.97	1.070	3.512	1.401	0.315	4.852	0.782	4.070	
23	0.264	13.37	25.99	1.114	3.655	1.557	0.350	4.978	0.940	4.038	
24	0.274	13.87	26.96	1.156	3.792	1.757	0.395	5.219	1.211	4.008	
25	0.284	14.40	28.00	1.200	3.938	2.010	0.452	5.538	1.560	3.978	

Table 13

REPEATABILITY EXPERIMENTS

Froude Number	0.18	0.24	0.28
Model	Percentage Difference	Percentage Difference	Percentage Difference
CVV-A	3.1	2.5	3.0
CVV-B	2.8	3.1	2.2
CVV-D	2.6	3.4	3.5

Percentage difference is the maximum difference in the resistance values / mean resistance $\times 100$.

Experiments were performed in the 140 Foot Basin at DTNSRDC with the small models.

APPENDIX A

SMALL MODEL DATA FROM THE DEEP WATER BASIN

A series of resistance experiments were performed in the Deep Water Basin with the small CVV models. Because of the small size of the models, the standard model towing system could not be used. The models were attached to the carriage through a vertical strut fastened to the top of the block gauge. The block gauge and a towing bracket were the same as used in the 140 Foot Basin experiments.

There were some problems with the small model resistance data, notably with CVV-D. Because of time constraints these difficulties were not resolved. Therefore, the small model CVV-D results from the Deep Water Basin are not presented in faired data-plots.

Figures A1 to A4 show the resistance data for the small CVV-A and CVV-B models. The data scatter is smaller than the scatter in the data from the 140 Foot Basin experiments because the sampling period is much longer, approximately 45 seconds. The resistance curves are faired using the residuary resistance coefficient curves (Figures A5 and A6) and the Prohaska plots (Figures A7 and A8).

Figure A9 shows the curves of $R_{TM}(\text{Deep Water basin})/R_{TM}(\text{140 Foot Basin})$ for the CVV-A and CVV-B small models. Generally, the resistance values of the small models from the Deep Water Basin are within 1 1/2 percent of the 140 Foot Basin resistance values.

The unfaired data obtained in the Deep Water Basin for the small models are listed in Tables A1 through A6.

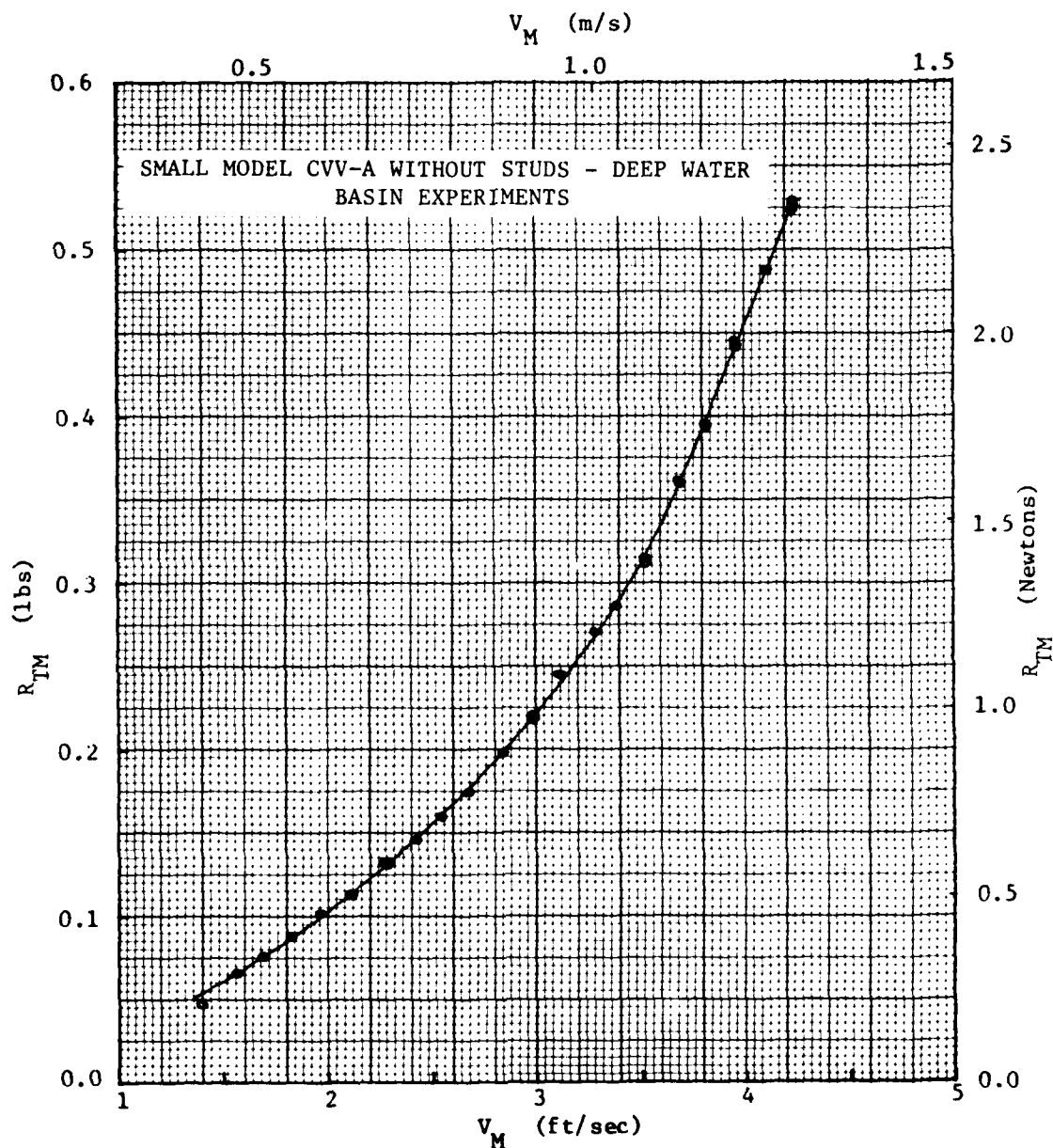


FIGURE A1 - RESISTANCE VALUES FOR THE SMALL CVV-A MODEL WITHOUT STUDS FROM THE DEEP WATER BASIN EXPERIMENTS

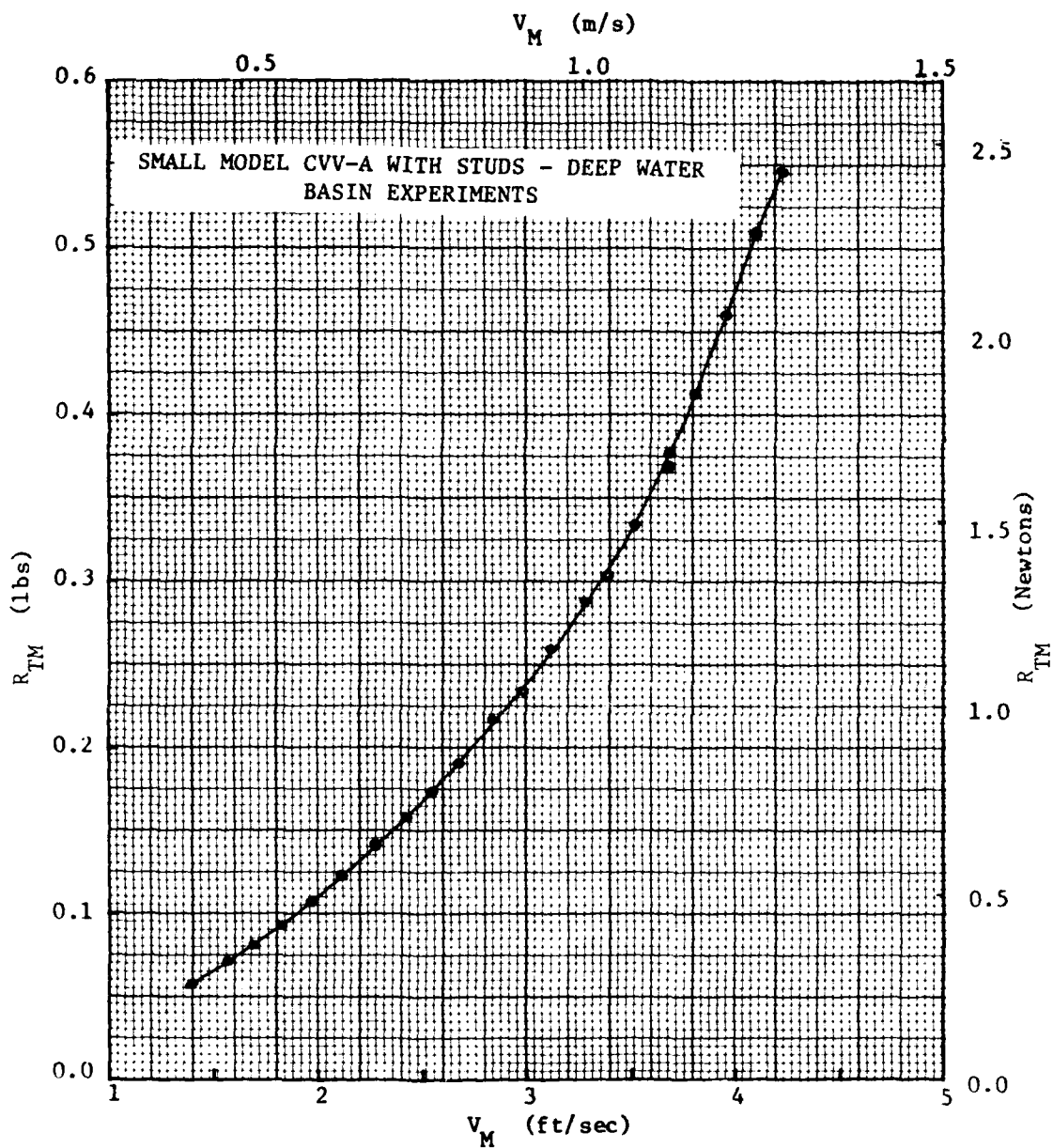
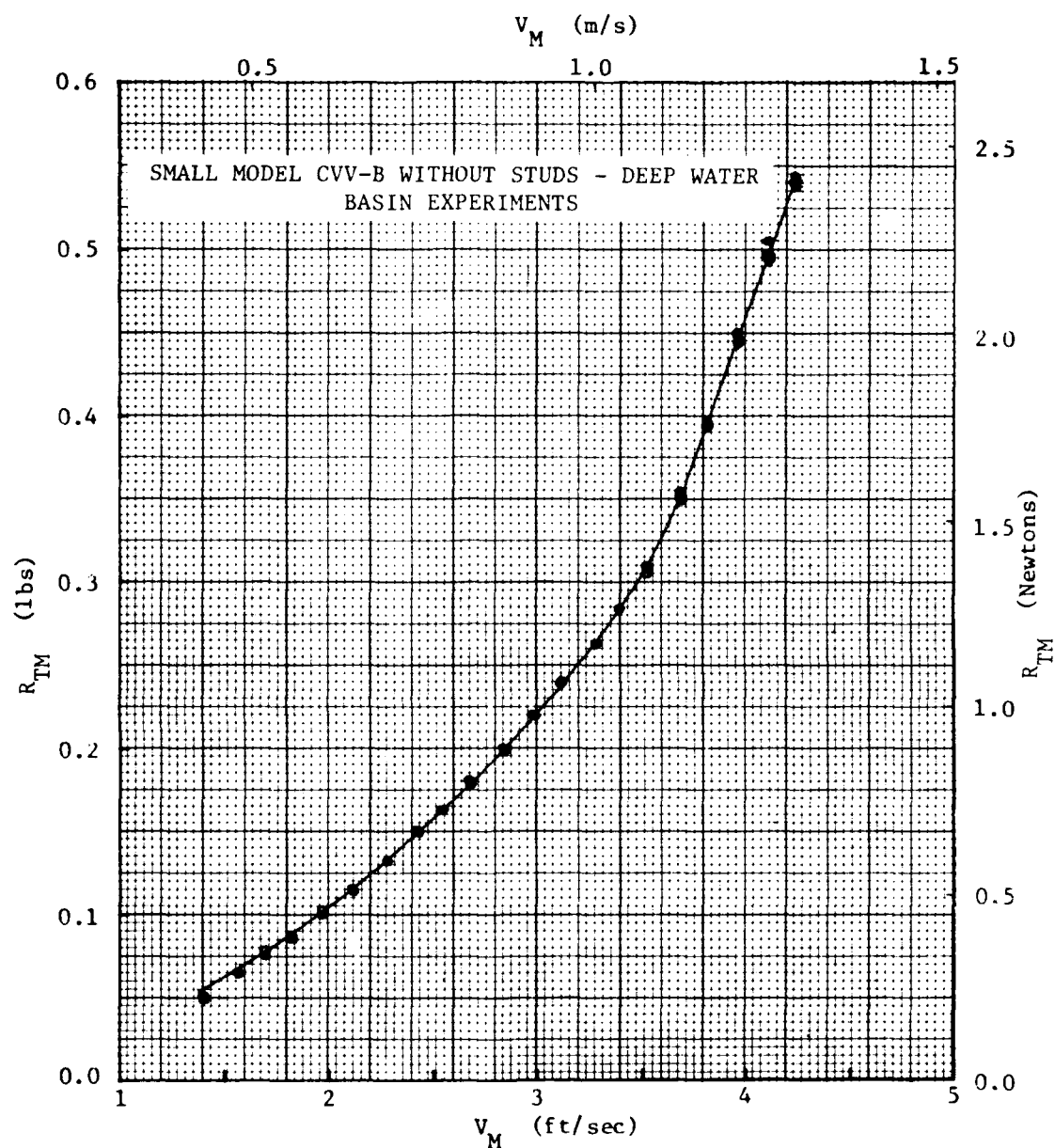


FIGURE A2 - RESISTANCE VALUES FOR THE SMALL CVV-A MODEL WITH STUDS FROM THE DEEP WATER BASIN EXPERIMENTS



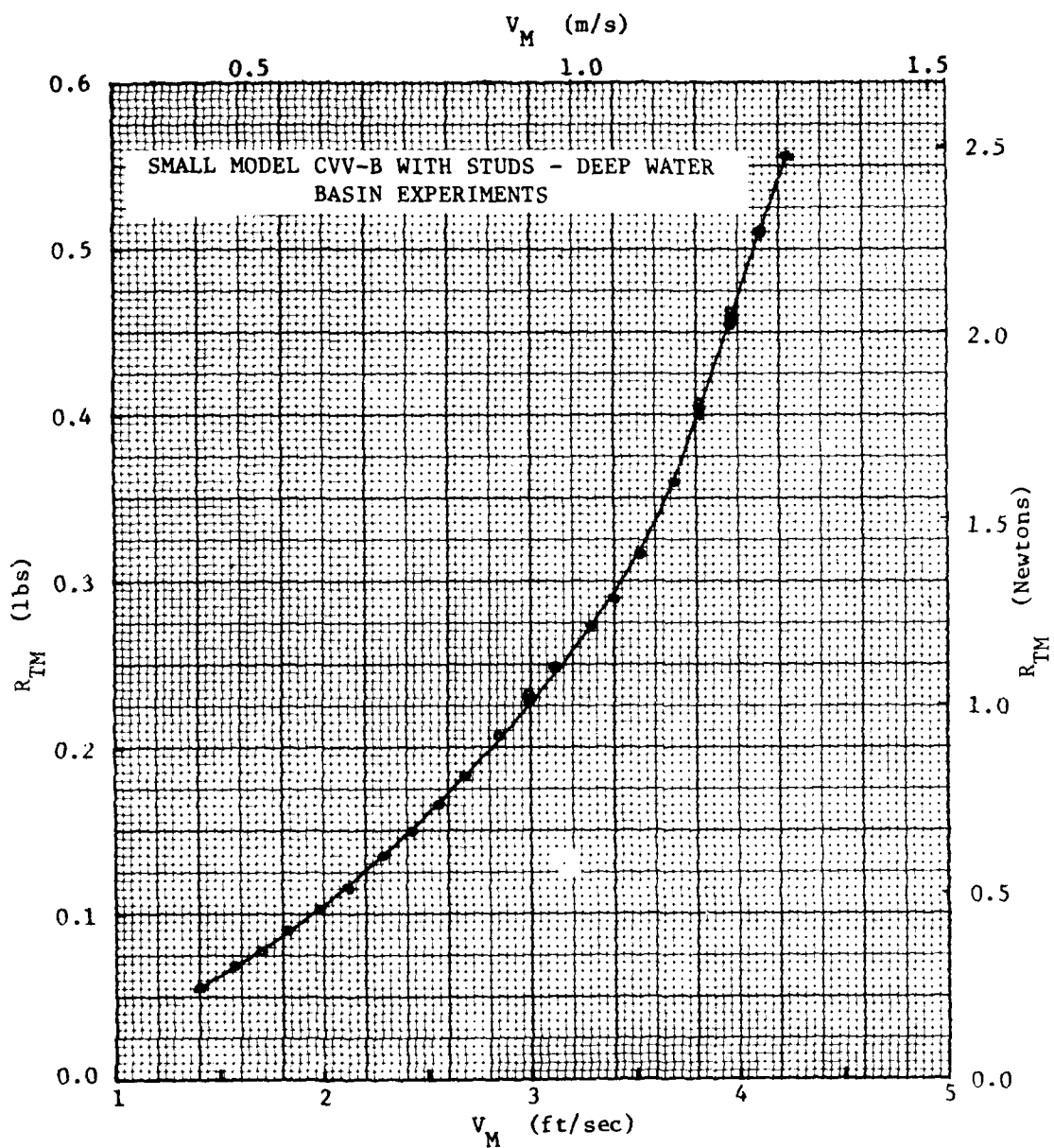


FIGURE A4 - RESISTANCE VALUES FOR THE SMALL CVV-B MODEL WITH STUDS FROM THE DEEP WATER BASIN EXPERIMENTS

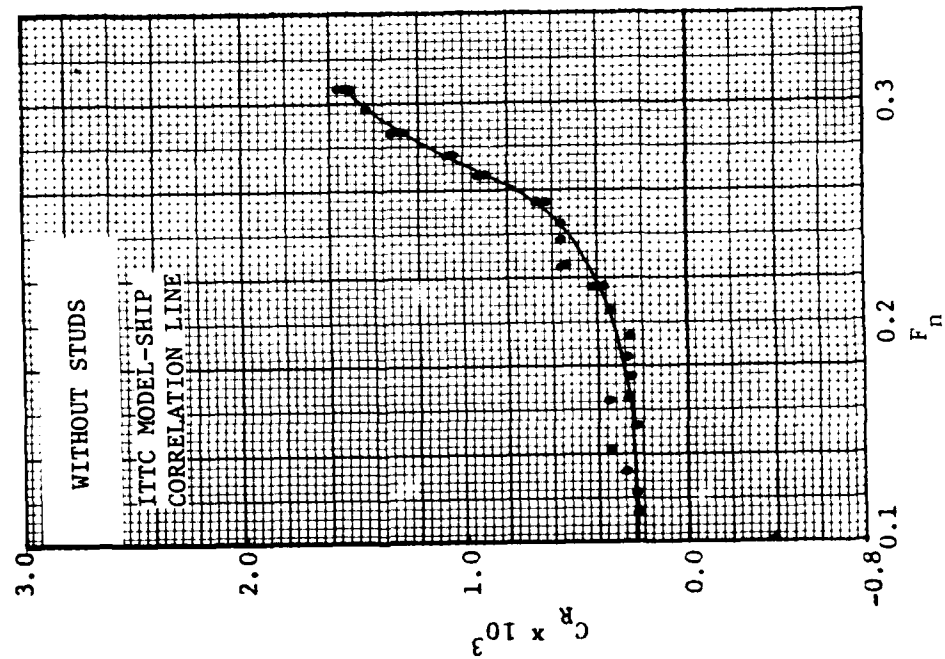
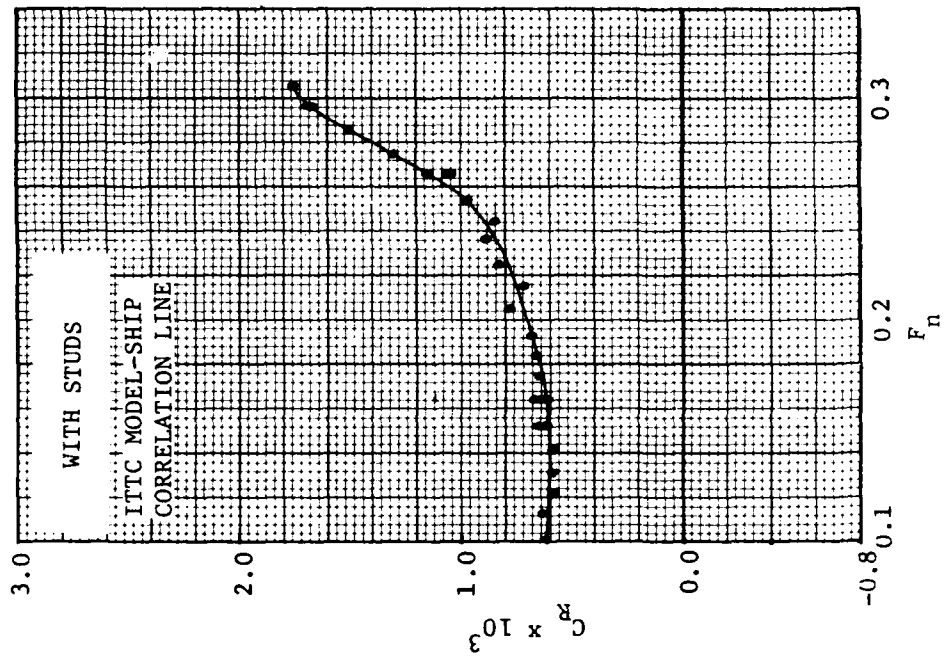


FIGURE A5 - RESIDUARY RESISTANCE COEFFICIENT CURVES FOR THE SMALL CVV-A MODEL FROM THE DEEP WATER BASIN EXPERIMENTS

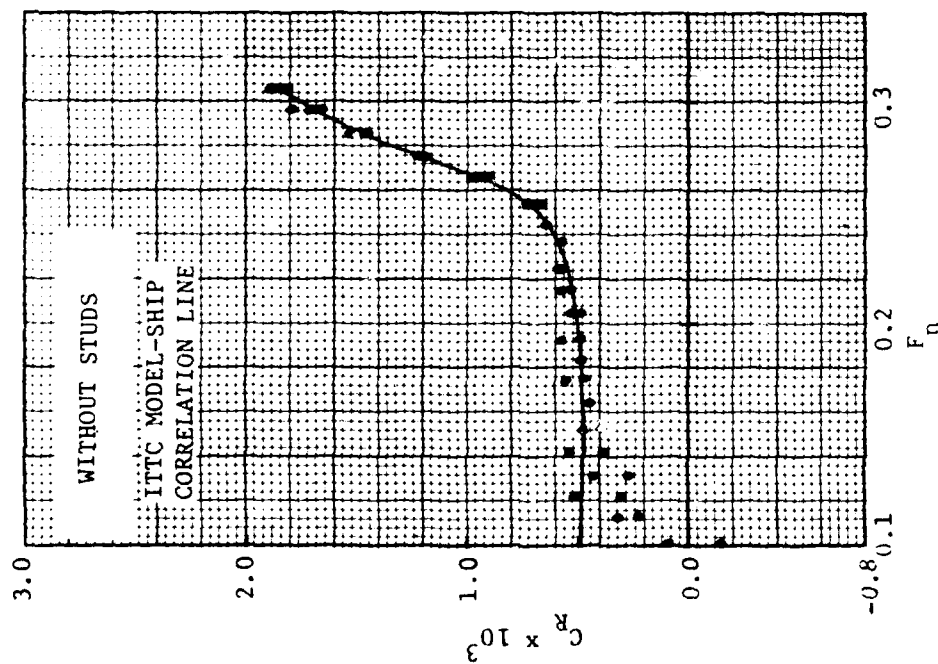
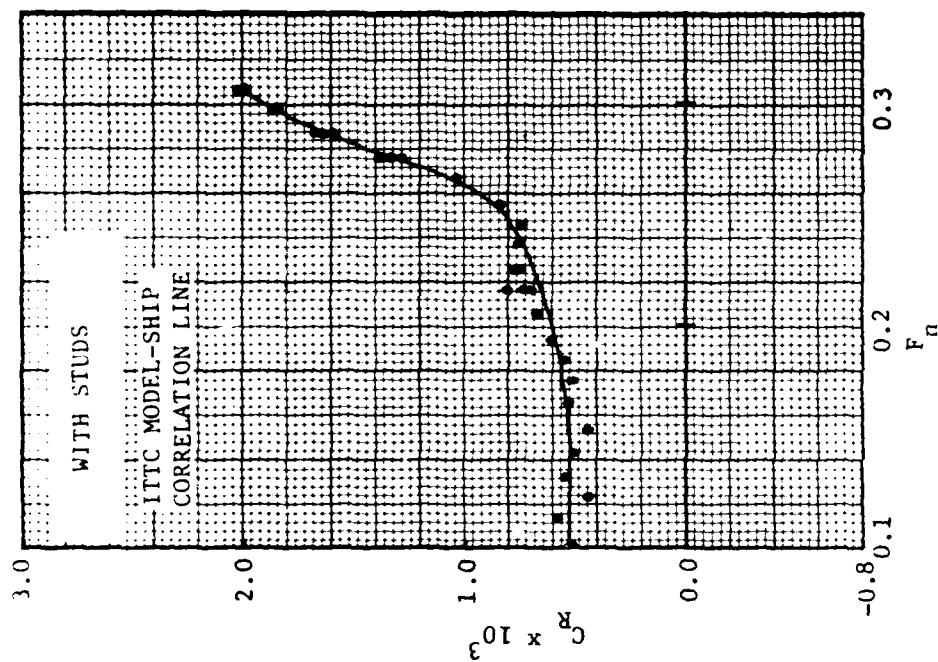


FIGURE A6 - RESIDUARY RESISTANCE COEFFICIENT CURVES FOR THE SMALL CVV-B
MODEL FROM THE DEEP WATER BASIN EXPERIMENTS

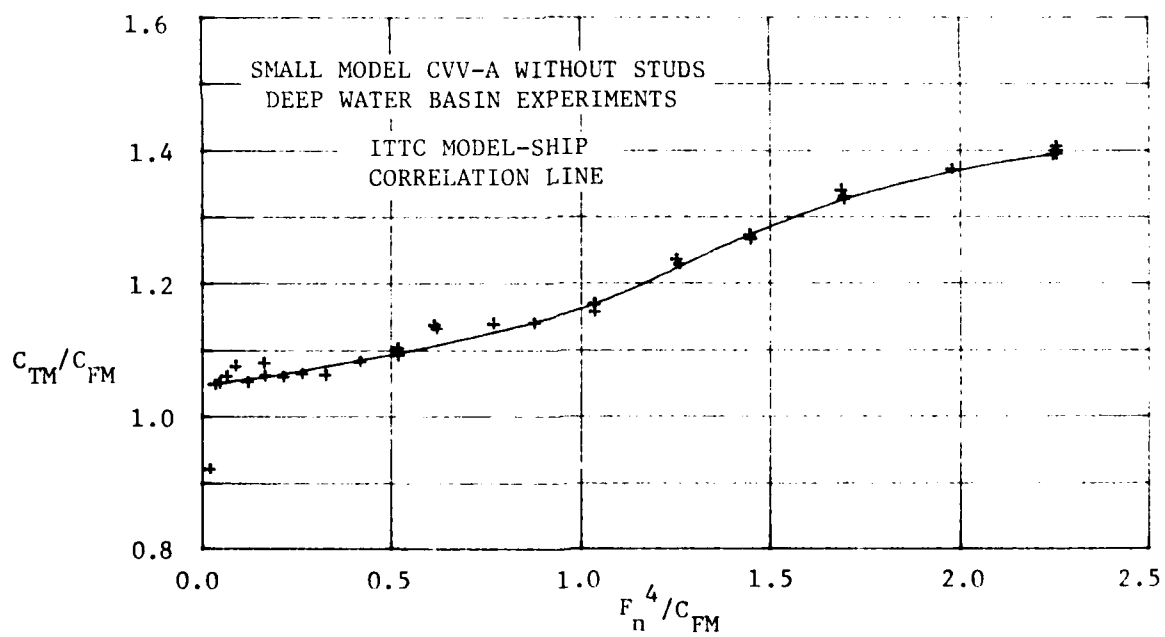
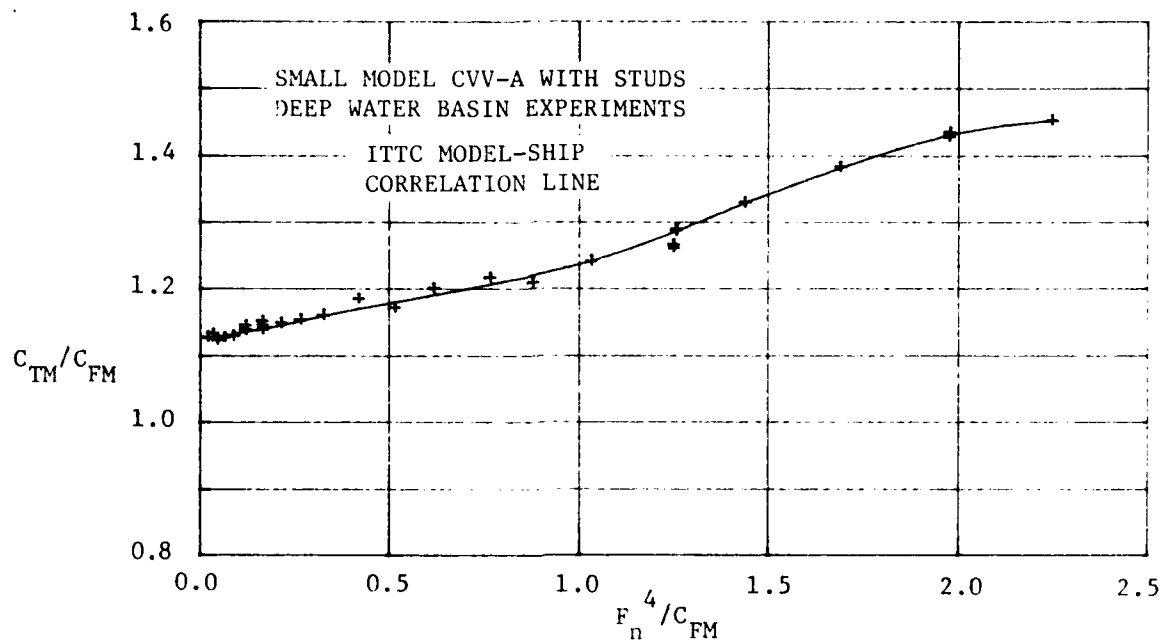


FIGURE A7 - PROHASKA PLOTS FOR THE SMALL CVV-A MODEL FROM THE DEEP WATER BASIN EXPERIMENTS

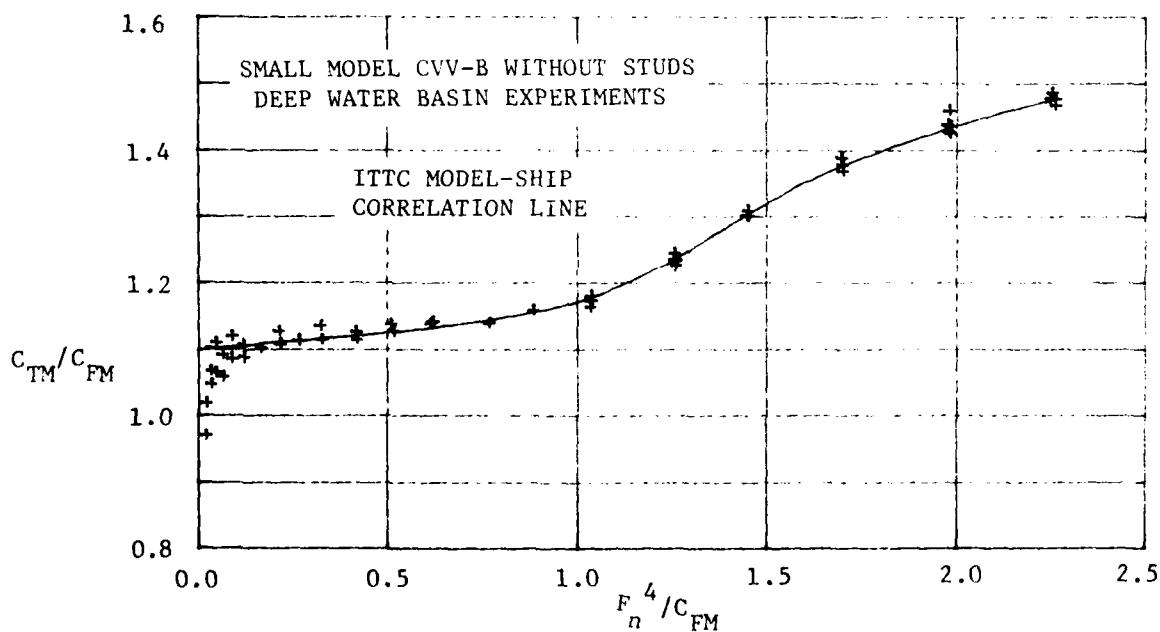
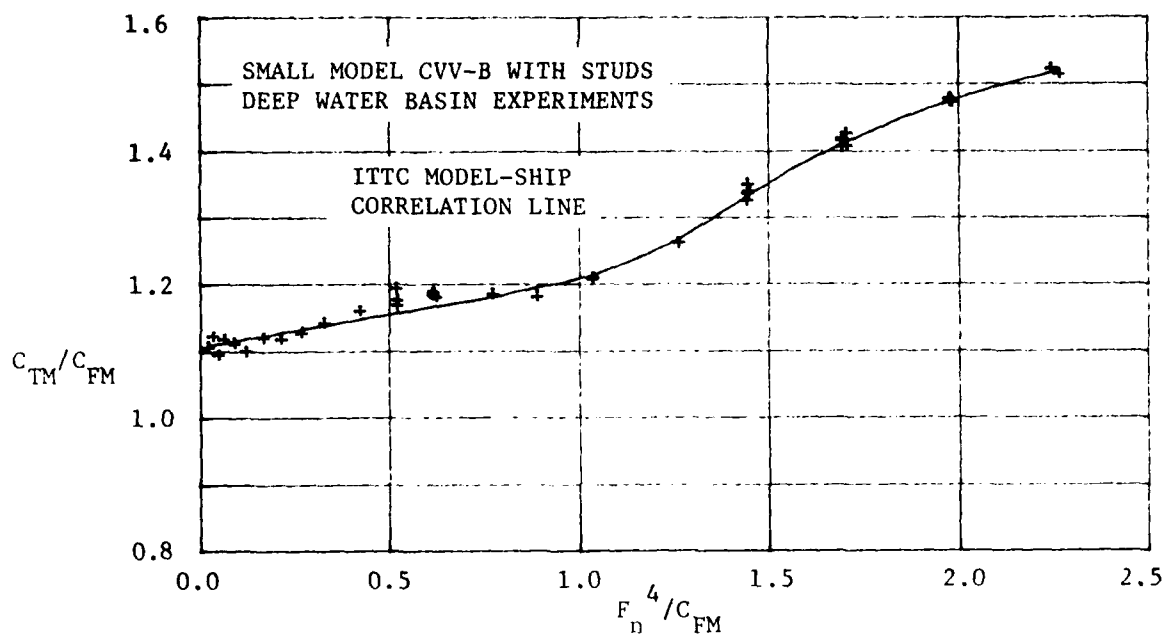


FIGURE A8 - PRO-ASKA PLOTS FOR THE SMALL CVV-B MODEL FROM THE DEEP WATER BASIN EXPERIMENTS

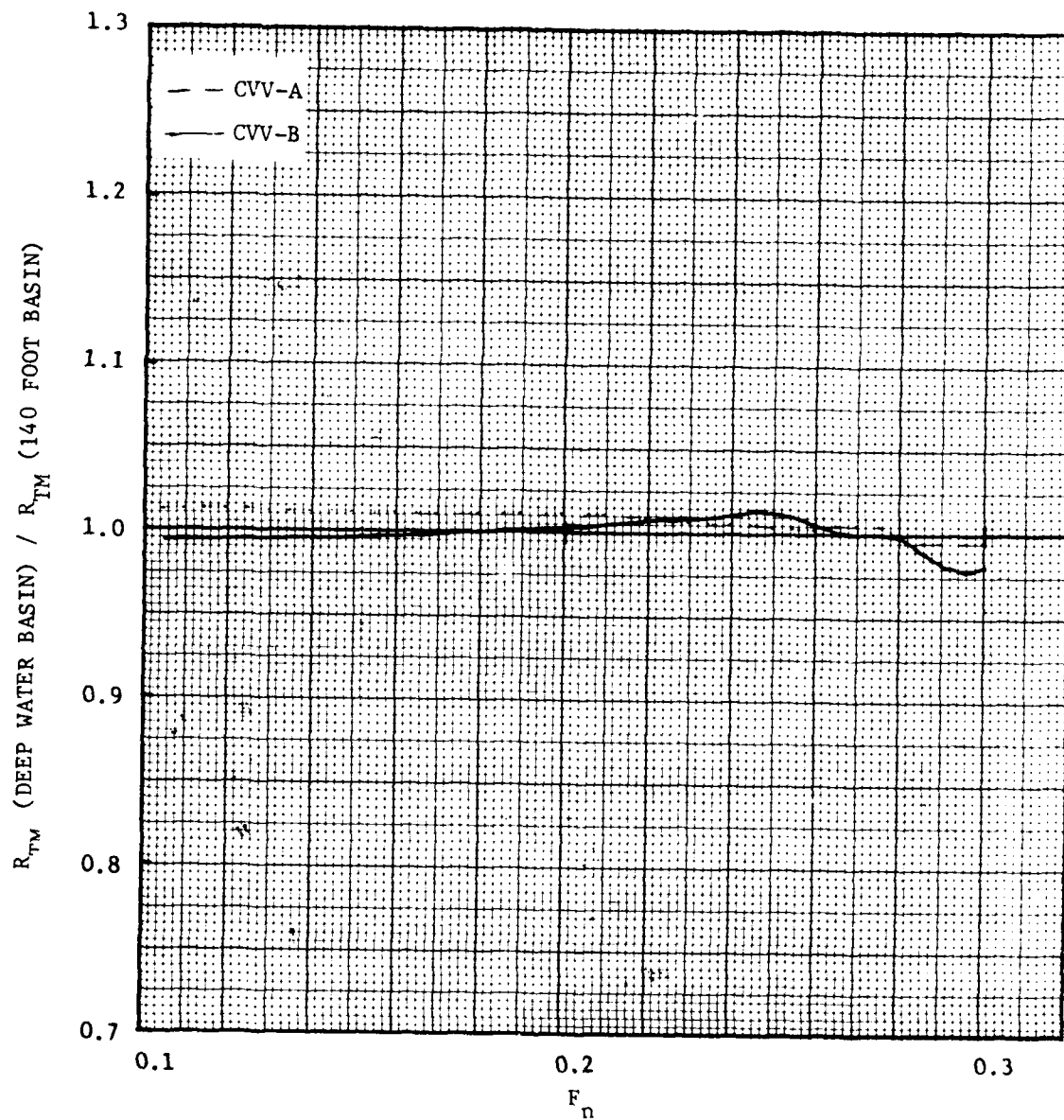


FIGURE A9 - $R_{TM}(\text{DEEP WATER BASIN}) / R_{TM}(140 \text{ FOOT BASIN})$ FOR THE SMALL CVV-A AND CVV-B MODELS

TABLE A1 - UNFINISHED RESISTANCE DATA FOR THE SMALL CVV-A MODEL WITHOUT STUDS FROM THE DEEP WATER BASIN EXPERIMENTS

POINT	LENGTH WETTED SURFACE FOUDES NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M	5.97 FT	DENSITY		997.4 KG/M ³	1.9352 SLUGS/FT ³	KINEMATIC		0.9307E-6 M ² /S	1.0018E-5 FT ² /S
		0.520 M ²	5.597 FT ²	VISCOSITY		RTM	RTM	RTM		CTM	CR
		VS (M/S)	VS (KNOTS)	V ³ (M/S)	VM (FT/SEC)	RTM (N)	RTM (LBS)	CTM (N)	CTM (LBS)	CR *1000	CFM *1000
1	0.101	5.10	9.91	0.425	1.394	0.210	0.047	4.492	4.492	-0.390	4.882
2	0.122	6.18	12.02	0.515	1.690	0.338	0.076	4.910	4.910	0.230	4.680
3	0.141	7.17	13.94	0.598	1.961	0.459	0.102	4.745	4.745	0.342	4.533
4	0.164	8.31	16.15	0.692	2.271	0.589	0.133	4.745	4.745	0.351	4.394
5	0.183	9.30	18.07	0.775	2.542	0.710	0.160	4.562	4.562	0.271	4.291
6	0.205	10.37	20.16	0.864	2.836	0.879	0.198	4.537	4.537	0.342	4.195
7	0.224	11.37	22.10	0.947	3.108	1.082	0.245	4.681	4.681	0.564	4.118
8	0.244	12.38	24.08	1.041	3.344	1.272	0.268	4.611	4.611	0.604	4.047
9	0.266	13.47	26.18	1.123	3.683	1.606	0.361	4.916	4.916	0.937	3.979
10	0.285	14.46	28.11	1.205	3.954	1.979	0.445	5.254	5.254	1.331	3.923
11	0.305	15.48	30.09	1.290	4.232	2.323	0.522	5.385	5.385	1.515	3.871
12	0.313	5.71	11.11	0.476	1.562	0.293	0.066	4.985	4.985	0.225	4.761
13	0.331	6.66	12.94	0.555	1.820	0.390	0.088	4.882	4.882	0.276	4.606
14	0.352	7.72	15.01	0.643	2.111	0.503	0.113	4.688	4.688	0.226	4.462
15	0.375	8.86	17.21	0.738	2.421	0.648	0.146	4.590	4.590	0.255	4.335
16	0.393	9.78	19.00	0.815	2.673	0.776	0.174	4.506	4.506	0.259	4.247
17	0.415	10.92	21.22	0.910	2.985	0.982	0.221	4.577	4.577	0.426	4.152
18	0.435	10.92	21.23	0.910	2.986	0.972	0.219	4.526	4.526	0.375	4.151
19	0.455	10.92	21.22	0.910	2.985	0.976	0.219	4.545	4.545	0.393	4.152
20	0.475	10.92	21.22	0.910	2.985	0.976	0.219	4.545	4.545	0.393	4.152
21	0.495	12.00	23.33	1.000	3.281	1.203	0.270	4.639	4.639	0.567	4.073
22	0.515	12.87	25.02	1.073	3.519	1.400	0.315	4.692	4.692	0.676	4.016
23	0.535	13.94	27.10	1.162	3.811	1.758	0.395	5.025	5.025	1.073	3.952
24	0.555	15.02	29.20	1.252	4.107	2.168	0.487	5.336	5.336	1.443	3.894
25	0.575	13.49	26.22	1.124	3.688	1.600	0.360	4.882	4.882	0.904	3.978
26	0.595	13.49	26.22	1.124	3.688	1.600	0.360	4.882	4.882	0.904	3.978
27	0.615	14.48	28.15	1.207	3.959	1.968	0.443	5.213	5.213	1.291	3.922
28	0.635	14.48	28.14	1.206	3.958	1.961	0.441	5.198	5.198	1.275	3.922
29	0.655	12.87	25.03	1.073	3.520	1.400	0.315	4.689	4.689	0.674	4.015
30	0.675	12.87	25.03	1.073	3.520	1.386	0.312	4.643	4.643	0.628	4.015
31	0.695	13.95	27.11	1.162	3.813	1.751	0.394	5.000	5.000	1.049	3.952
32	0.715	13.95	27.11	1.162	3.813	1.751	0.394	5.000	5.000	1.049	3.952
33	0.735	8.34	16.20	0.695	2.279	0.583	0.131	4.656	4.656	0.266	4.390
34	0.755	11.40	22.15	0.950	3.116	1.089	0.245	4.657	4.657	0.542	4.115
35	0.775	15.50	30.13	1.232	4.238	2.341	0.526	5.410	5.410	1.540	3.870
36	0.795	15.50	30.12	1.231	4.237	2.331	0.529	5.436	5.436	1.567	3.870
37	0.815	15.50	30.12	1.231	4.237	2.330	0.524	5.389	5.389	1.519	3.870

TABLE A2 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-A MODEL WITH
STUDS FROM THE DEEP WATER BASIN EXPERIMENTS

POINT	LENGTH WEIRED SURFACE FROUDE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M		5.97 FT		997.4 KG/M ³		1.9352 SLUGS/FT ³		1.0018E-5 FT ² /S	
		0.520 M ²		5.97 FT ²		KINEMATIC		0.9307E-6 M ² /S		1.0018E-5 FT ² /S	
		VS (M/S)	VS (KNOTS)	VII (M/S)	VM (FT/SEC)	RTM (N)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000	
1	0.101	5.11	9.93	0.426	1.397	0.259	0.058	5.499	0.620	4.879	
2	0.122	6.19	12.02	0.515	1.691	0.362	0.081	5.255	0.575	4.679	
3	0.142	7.19	13.97	0.599	1.965	0.476	0.107	5.115	0.584	4.531	
4	0.164	8.32	16.17	0.693	2.275	0.631	0.142	5.060	0.668	4.392	
5	0.184	9.31	18.09	0.776	2.545	0.772	0.174	4.949	0.659	4.290	
6	0.205	10.38	20.18	0.865	2.839	0.965	0.217	4.971	0.777	4.195	
7	0.225	11.39	22.14	0.949	3.114	1.155	0.260	4.944	0.828	4.116	
8	0.244	12.38	24.07	1.032	3.386	1.351	0.304	4.893	0.846	4.047	
9	0.266	13.49	26.21	1.124	3.687	1.679	0.377	5.127	1.149	3.978	
10	0.286	14.47	28.13	1.206	3.956	2.044	0.460	5.422	1.500	3.923	
11	0.313	5.72	11.11	0.476	1.563	0.317	0.071	5.389	0.629	4.760	
12	0.331	6.65	12.93	0.554	1.819	0.414	0.093	5.190	0.584	4.606	
13	0.352	7.72	15.00	0.643	2.110	0.548	0.123	5.111	0.648	4.462	
14	0.375	8.86	17.21	0.738	2.421	0.703	0.158	4.981	0.645	4.335	
15	0.393	9.78	19.00	0.815	2.673	0.848	0.191	4.927	0.680	4.247	
16	0.415	10.90	21.19	0.908	2.980	1.041	0.234	4.867	0.713	4.153	
17	0.436	11.99	23.30	0.999	3.277	1.282	0.288	4.957	0.884	4.074	
18	0.454	12.87	25.01	1.072	3.518	1.486	0.334	4.984	0.968	4.016	
19	0.475	13.92	27.07	1.160	3.807	1.834	0.412	5.253	1.300	3.953	
20	0.496	15.02	29.20	1.252	4.107	2.268	0.510	5.582	1.689	3.894	
21	0.516	15.02	29.19	1.252	4.106	2.258	0.508	5.560	1.666	3.894	
22	0.535	15.49	30.10	1.291	4.234	2.427	0.546	5.620	1.750	3.870	
23	0.552	7.72	15.01	0.643	2.111	0.545	0.122	5.074	0.612	4.462	
24	0.572	7.72	15.00	0.643	2.110	0.545	0.122	5.079	0.616	4.462	
25	0.592	8.32	16.13	0.694	2.276	0.627	0.141	5.028	0.636	4.392	
26	0.614	8.32	16.18	0.694	2.276	0.624	0.140	5.000	0.608	4.392	
27	0.636	13.47	26.18	1.122	3.682	1.644	0.370	5.035	1.056	3.979	
28	0.656	13.46	26.17	1.122	3.681	1.637	0.368	5.017	1.037	3.979	
29	0.676										

TABLE A3 - UNFAIRED RESISTANCE DATA FOR THE SMALL CUV-B MODEL WITHOUT STUDS FROM THE DEEP WATER BASIN EXPERIMENTS

POINT	FROUDE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES											
		1.820 M 0.505 M ²		5.97 FT 5.436 FT ²		VS (KNOTS)	V/M (M/S)	V/M (FT/SEC)	RTM (N)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000
		VS (M/S)	VS (KNOTS)	VS (KNOTS)	VS (M/S)								
		DENSITY 997.4 KG/M ³	VISCOSITY 0.9307E-6 M ² .S	1.9352 SLUGS FT ² .S	1.0018E-5 FT ² .S								
1	0.101	5.12	9.95	0.426	1.399	0.228	0.051	4.969	0.091	4.278			
2	0.122	6.19	12.04	0.516	1.693	0.348	0.078	5.192	0.514	4.678			
3	0.142	7.19	13.98	0.599	1.966	0.458	0.103	5.070	0.540	4.530			
4	0.164	8.32	16.18	0.694	2.276	0.586	0.132	4.935	0.444	4.392			
5	0.184	9.31	18.10	0.776	2.546	0.724	0.163	4.773	0.483	4.290			
6	0.205	10.38	20.17	0.865	2.837	0.889	0.200	4.723	0.529	4.195			
7	0.225	11.40	22.16	0.950	3.117	1.069	0.240	4.701	0.586	4.115			
8	0.245	12.41	24.12	1.034	3.392	1.252	0.284	4.687	0.542	4.045			
9	0.266	13.49	26.21	1.124	3.687	1.562	0.351	4.910	0.932	3.978			
10	0.286	14.49	28.16	1.207	3.961	1.939	0.450	5.447	1.525	3.922			
11	0.286	14.48	28.15	1.207	3.960	1.999	0.450	5.450	1.528	3.922			
12	0.306	15.49	30.12	1.291	4.236	2.416	0.543	5.756	1.886	3.870			
13	0.305	15.49	30.10	1.291	4.234	2.399	0.539	5.720	1.850	3.870			
14	0.113	5.71	11.10	0.476	1.561	0.290	0.065	5.079	0.318	4.762			
15	0.131	6.65	12.93	0.554	1.819	0.390	0.088	5.032	0.426	4.606			
16	0.152	7.71	14.99	0.643	2.109	0.514	0.115	4.936	0.473	4.463			
17	0.174	8.84	17.19	0.737	2.418	0.669	0.150	4.889	0.553	4.236			
18	0.192	9.76	18.97	0.813	2.668	0.803	0.181	4.823	0.574	4.249			
19	0.215	10.88	21.15	0.907	2.975	0.979	0.220	4.728	0.573	4.155			
20	0.275	13.95	27.12	1.163	3.814	1.762	0.396	5.176	1.225	3.951			
21	0.296	15.03	29.21	1.252	4.108	2.244	0.505	5.684	1.790	3.893			
22	0.296	15.02	29.19	1.252	4.106	2.210	0.497	5.602	1.708	3.894			
23	0.237	12.00	23.32	1.000	3.280	1.169	0.263	4.643	0.570	4.073			
24	0.254	12.88	25.03	1.073	3.521	1.375	0.309	4.742	0.727	4.015			
25	0.266	13.49	26.23	1.124	3.689	1.565	0.352	4.915	0.938	3.978			
26	0.266	13.49	26.22	1.124	3.688	1.551	0.349	4.875	0.897	3.978			
27	0.101	5.12	9.96	0.427	1.401	0.217	0.049	4.729	-0.147	4.876			
28	0.122	6.20	12.04	0.516	1.694	0.334	0.075	4.980	0.303	4.678			
29	0.142	7.19	13.98	0.599	1.966	0.445	0.100	4.918	0.388	4.530			
30	0.164	8.32	16.18	0.694	2.276	0.586	0.132	4.835	0.444	4.392			
31	0.184	9.31	18.09	0.776	2.545	0.724	0.163	4.777	0.487	4.290			
32	0.205	10.39	20.19	0.865	2.840	0.882	0.198	4.677	0.482	4.194			
33	0.224	11.38	22.11	0.948	3.110	1.062	0.239	4.692	0.575	4.117			
34	0.245	12.41	24.12	1.034	3.392	1.262	0.284	4.687	0.642	4.045			
35	0.266	13.48	26.21	1.123	3.685	1.575	0.354	4.956	0.978	3.978			
36	0.266	13.48	26.20	1.123	3.685	1.562	0.351	4.915	0.937	3.979			
37	0.286	14.49	28.17	1.208	3.962	1.972	0.443	5.369	1.448	3.921			
38	0.286	14.49	28.17	1.208	3.962	1.986	0.446	5.407	1.485	3.921			
39	0.306	15.51	30.15	1.292	4.240	2.406	0.541	5.721	1.852	3.869			
40	0.306	15.51	30.15	1.292	4.240	2.393	0.537	5.660	1.811	3.869			
41	0.254	12.87	25.03	1.073	3.520	1.355	0.305	4.673	0.558	4.015			
42	0.275	13.95	27.13	1.163	3.816	1.751	0.341	5.140	1.189	3.951			
43	0.297	15.03	29.22	1.253	4.110	2.246	0.504	5.691	1.698	3.893			
44	0.297	15.03	29.22	1.253	4.110	2.232	0.493	5.644	1.654	3.893			
45	0.113	5.71	11.14	0.476	1.567	0.290	0.064	5.080	0.222	4.758			

TABLE A3 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-B MODEL WITHOUT
STUDS FROM THE DEEP WATER BASIN EXPERIMENTS
(CONTINUED)

POINT	LENGTH WEIRED SURFACE FROUDE NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES		DENSITY		KINEMATIC		VISCOSITY		RTM		RTM		CTM		CR		CFM	
		1.820 M	5.97 FT	VS (M/S)	VS (KNOTS)	VM (FT/SEC)	RTM (N)	RTM (LBS)	CTM (1000)	CR (1000)	CFM (1000)	1.9352 SLUGS/FT ³	0.9307E-6 M ² /S	1.0018E-5 FT ² /S	1.9352 SLUGS/FT ³	0.9307E-6 M ² /S	1.0018E-5 FT ² /S	1.9352 SLUGS/FT ³	0.9307E-6 M ² /S
46	0.132	6.67	12.97	0.555	1.824	0.379	0.035	4.872	4.603	0.268	4.603								
47	0.152	7.73	15.02	0.644	2.113	0.507	0.114	4.851	4.461	0.350	4.461								
48	0.175	8.88	17.26	0.740	2.427	0.662	0.149	4.803	4.333	0.476	4.333								
49	0.193	9.79	19.03	0.815	2.676	0.793	0.178	4.732	4.246	0.486	4.246								
50	0.215	10.92	21.22	0.910	2.985	0.976	0.219	4.680	4.152	0.528	4.152								
51	0.237	12.00	23.32	1.000	3.290	1.169	0.263	4.643	4.073	0.576	4.073								
52	0.254	12.89	25.05	1.074	3.523	1.369	0.308	4.713	4.015	0.698	4.015								
53	0.275	13.94	27.10	1.162	3.812	1.748	0.393	5.141	3.852	1.189	3.852								
54	0.296	15.03	29.21	1.252	4.108	2.196	0.494	5.562	3.693	1.668	3.693								

TABLE A3 - UNFURNISHED RESISTANCE DATA FOR THE SMALL CUV-B MODEL WITH STUDS FROM THE DEEP WATER BASIN EXPERIMENTS

POINT	LENGTH WETTED SURFACE FRONTS NUMBER	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES									
		1.820 M 0.505 M ²		5.97 FT 5.436 FT ²		DENSITY KINEMATIC VISCOSITY		997.4 KG/M ³ 0.9307E-6 M ² /S		1.9352 SLUGS/FT ² 1.0018E-5 FT ² /S	
		VS (M/S)	VS (KNOTS)	V/M (M/S)	VM (FT/SEC)	RTM (N)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000	
1	0.101	5.13	9.97	0.427	1.402	0.248	0.056	5.397	0.522	4.876	
2	0.122	6.21	12.07	0.517	1.697	0.345	0.078	5.116	0.441	4.676	
3	0.142	7.22	14.03	0.601	1.973	0.458	0.103	5.034	0.508	4.527	
4	0.165	8.35	16.23	0.696	2.283	0.600	0.135	4.809	0.530	4.389	
5	0.184	9.34	18.15	0.778	2.553	0.738	0.166	4.838	0.550	4.288	
6	0.205	10.40	20.21	0.867	2.843	0.920	0.207	4.867	0.674	4.193	
7	0.225	11.40	22.17	0.950	3.118	1.107	0.249	4.865	0.750	4.115	
8	0.245	12.41	24.13	1.034	3.394	1.289	0.290	4.784	0.739	4.045	
9	0.266	13.50	26.24	1.125	3.690	1.600	0.360	5.021	1.044	3.977	
10	0.286	14.50	28.18	1.208	3.964	2.058	0.463	5.598	1.677	3.921	
11	0.286	14.50	28.19	1.209	3.965	2.030	0.456	5.520	1.599	3.921	
12	0.306	15.52	30.16	1.293	4.242	2.468	0.555	5.863	1.994	3.869	
13	0.113	5.73	11.14	0.478	1.567	0.307	0.069	5.340	0.583	4.758	
14	0.131	6.66	12.95	0.555	1.822	0.400	0.090	5.149	0.544	4.605	
15	0.153	7.74	15.04	0.645	2.116	0.514	0.115	4.903	0.443	4.460	
16	0.175	8.86	17.22	0.738	2.422	0.665	0.150	4.848	0.513	4.335	
17	0.193	9.79	19.03	0.816	2.677	0.814	0.183	4.852	0.607	4.246	
18	0.215	10.92	21.22	0.910	2.985	1.034	0.233	4.961	0.809	4.152	
19	0.237	12.01	23.34	1.001	3.283	1.217	0.274	4.826	0.754	4.072	
20	0.254	12.87	25.03	1.073	3.520	1.410	0.317	4.864	0.848	4.015	
21	0.254	12.87	25.03	1.073	3.520	1.406	0.316	4.852	0.837	4.015	
22	0.275	13.94	27.09	1.161	3.810	1.813	0.408	5.339	1.387	3.952	
23	0.275	13.94	27.09	1.161	3.810	1.779	0.400	5.238	1.285	3.952	
24	0.296	15.03	29.21	1.252	4.108	2.268	0.510	5.745	1.852	3.893	
25	0.296	15.03	29.21	1.252	4.108	2.265	0.509	5.736	1.843	3.893	
26	0.216	10.93	21.24	0.911	2.988	1.020	0.229	4.885	0.734	4.151	
27	0.216	10.93	21.24	0.911	2.988	1.013	0.228	4.852	0.701	4.151	
28	0.275	13.94	27.10	1.162	3.812	1.799	0.405	5.293	1.341	3.952	
29	0.275	13.94	27.10	1.162	3.812	1.796	0.404	5.233	1.331	3.952	
30	0.286	14.48	28.14	1.206	3.958	2.041	0.459	5.568	1.646	3.922	
31	0.286	14.47	28.13	1.206	3.957	2.020	0.454	5.514	1.592	3.922	
32	0.296	15.02	29.20	1.252	4.107	2.272	0.511	5.757	1.863	3.894	
33	0.296	15.02	29.19	1.252	4.106	2.265	0.509	5.742	1.848	3.894	
34	0.286	14.48	28.15	1.207	3.959	2.037	0.458	5.556	1.634	3.922	
35	0.286	14.48	28.14	1.206	3.958	2.037	0.458	5.559	1.636	3.922	
36	0.296	15.02	29.19	1.252	4.106	2.272	0.511	5.759	1.866	3.894	
37	0.224	11.37	22.10	0.948	3.109	1.107	0.249	4.893	0.776	4.117	
38	0.224	11.37	22.10	0.947	3.108	1.103	0.248	4.881	0.763	4.118	
39	0.305	15.46	30.10	1.290	4.233	2.472	0.556	5.896	2.025	3.870	
40	0.305	15.46	30.10	1.290	4.233	2.472	0.556	5.896	2.025	3.870	

TABLE A5 - UNFAIRED RESISTANCE DATA FOR THE SMALL CVV-D MODEL WITHOUT STUDES FROM THE DEE WATER BASIN EXPERIMENTS

POINT	ITTC MODEL-SHIP CORRELATION LINE USED FOR CR, CFM VALUES												
	LENGTH WEIETED SURFACE	1.820 M		5.97 FT		DENSITY 997.4 KG/M ³		1.9352 S-UGS/FT ³		KINEMATIC 0.9307E-6 M ² /S		1.0018E-5 FT ² /S	
		PROUDE NUMBER	VS (M/S)	VS (KNOTS)	V2 (M/S)	VM (FT/SEC)	RTW (N)	RTM (LBS)	CTM *1000	CR *1000	CFM *1000		
1	0.101	5.11	9.93	0.426	1.396	0.228	0.051	4.919	0.039	4.880			
2	0.122	6.19	12.02	0.515	1.691	0.341	0.077	5.029	0.350	4.679			
3	0.142	7.16	13.90	0.549	1.964	0.415	0.100	4.858	0.327	4.531			
4	0.164	8.32	16.18	0.614	2.275	0.576	0.129	4.583	0.291	4.392			
5	0.184	9.32	18.12	0.777	2.548	0.679	0.153	4.408	0.118	4.289			
6	0.205	10.38	20.18	0.855	2.839	0.841	0.189	4.397	0.203	4.195			
7	0.224	11.38	22.12	0.948	3.111	1.027	0.231	4.473	0.356	4.117			
8	0.244	12.37	24.08	1.012	3.407	1.214	0.277	4.533	0.487	4.047			
9	0.266	13.47	26.19	1.123	3.684	1.541	0.346	4.784	6.805	3.979			
10	0.285	14.47	28.13	1.206	3.957	1.979	0.445	5.325	1.403	3.922			
11	0.313	5.71	11.11	0.476	1.562	0.233	0.064	4.862	0.121	4.761			
12	0.331	6.66	12.95	0.555	1.821	0.383	0.086	4.862	0.257	4.605			
13	0.352	7.72	15.01	0.643	2.111	0.500	0.112	4.726	0.264	4.462			
14	0.375	8.86	17.21	0.738	2.421	0.627	0.141	4.510	0.175	4.335			
15	0.393	9.79	19.03	0.816	2.676	0.748	0.168	4.402	0.156	4.246			
16	0.415	10.91	21.21	0.909	2.983	0.914	0.205	4.326	0.174	4.152			
17	0.437	12.00	23.32	1.000	3.280	1.151	0.259	4.510	0.437	4.073			
18	0.454	12.87	25.02	1.073	3.519	1.365	0.307	4.645	0.630	4.016			
19	0.475	13.93	27.08	1.161	3.809	1.765	0.397	5.126	1.174	3.952			
20	0.496	15.03	29.21	1.252	4.109	2.268	0.510	5.661	1.768	3.893			
21	0.496	15.03	29.21	1.252	4.108	2.261	0.508	5.647	1.753	3.893			
22	0.306	15.49	30.11	1.291	4.235	2.430	0.546	5.710	1.840	3.870			
23	0.254	12.87	25.02	1.073	3.519	1.362	0.306	4.633	0.618	4.016			
24	0.254	12.87	25.02	1.073	3.519	1.365	0.307	4.645	0.630	4.016			
25	0.266	13.48	26.20	1.123	3.635	1.558	0.350	4.835	0.857	3.979			
26	0.266	13.48	26.20	1.123	3.635	1.551	0.349	4.814	0.835	3.979			
27	0.215	10.91	21.20	0.909	2.982	0.955	0.215	4.525	0.372	4.153			
28	0.215	10.91	21.21	0.909	2.983	0.951	0.214	4.505	0.353	4.152			
29	0.275	13.93	27.08	1.161	3.809	1.765	0.398	5.136	1.184	3.952			
30	0.275	13.93	27.08	1.161	3.809	1.755	0.394	5.096	1.144	3.952			

TABLE A6 - REFINED RESULTS FOR THE STOCKS FROM THE FIRST EXPERIMENTS WITH THE CVD MODEL.

POINT	LENGTH WEIRED SURFACE	ITTC MODEL-SHIP CORRELATION LINE USED FOR				CR, CFM VALUES				
		1.820 M	5.97 FT	0.512 M ²	5.514 FT ²	DENSITY KILONEUTIC VELOCITY	997.4 KG/M ³	1.9352 SLUGS/FT ³	0.9307E-6 M ² /S	1.0018E-5 FT ² /S
		VS (M/S)	VS (KNOTS)	VS (M/S)	VS (KNOTS)	RTM (N)	RTM (LBS)	CTM	CR	CFM
1	0.101	5.14	10.00	0.439	1.405	0.255	0.057	5.438	0.565	4.875
2	0.123	6.22	12.00	0.518	1.700	0.355	0.080	5.177	0.503	4.751
3	0.142	7.22	14.03	0.601	1.973	0.465	0.105	5.038	0.511	4.652
4	0.165	8.35	16.23	0.696	2.283	0.607	0.136	4.815	0.516	4.552
5	0.184	9.34	18.16	0.778	2.554	0.751	0.169	4.615	0.567	4.287
6	0.205	10.42	20.25	0.868	2.838	0.917	0.206	4.474	0.572	4.192
7	0.225	11.41	22.18	0.951	3.123	1.110	0.250	4.805	0.633	4.114
8	0.245	12.41	24.13	1.034	3.394	1.313	0.295	4.804	0.760	4.045
9	0.266	13.50	26.24	1.125	3.691	1.665	0.374	5.150	1.173	3.977
10	0.286	14.49	28.16	1.207	3.961	2.117	0.476	5.065	1.763	3.922
11	0.113	5.73	11.13	0.477	1.572	0.310	0.070	5.231	0.573	4.758
12	0.132	6.67	12.96	0.556	1.823	0.403	0.091	5.114	0.510	4.604
13	0.153	7.73	15.03	0.644	2.114	0.527	0.119	4.973	0.512	4.461
14	0.175	8.86	17.21	0.738	2.421	0.672	0.151	4.833	0.497	4.335
15	0.193	9.79	19.03	0.816	2.673	0.825	0.184	4.828	0.582	4.245
16	0.215	10.92	21.23	0.910	2.986	1.007	0.226	4.757	0.606	4.251
17	0.237	12.01	23.34	1.031	3.283	1.227	0.276	4.798	0.726	4.072
18	0.254	12.87	25.02	1.073	3.519	1.434	0.322	4.880	0.864	4.016
19	0.275	13.95	27.12	1.163	3.814	1.868	0.420	5.412	1.461	3.951
20	0.297	15.04	29.24	1.253	4.112	2.379	0.535	5.928	2.035	3.893
21	0.297	15.04	29.23	1.253	4.111	2.368	0.532	5.905	2.012	3.870
22	0.306	15.49	30.12	1.291	4.236	2.551	0.574	5.990	2.121	3.893
23	0.306	15.49	30.11	1.291	4.235	2.547	0.573	5.965	2.115	3.870
24	0.266	13.49	26.23	1.124	3.669	1.658	0.375	5.166	1.188	3.978
25	0.266	13.49	26.22	1.124	3.688	1.658	0.373	5.137	1.159	3.978
26	0.275	13.93	27.08	1.161	3.809	1.858	0.418	5.396	1.444	3.952
27	0.275	13.93	27.07	1.161	3.808	1.855	0.417	5.389	1.437	3.953
28	0.254	12.87	25.02	1.073	3.519	1.444	0.325	4.915	0.899	4.016
29	0.254	12.87	25.02	1.073	3.519	1.437	0.323	4.891	0.876	4.016
30	0.254	12.87	25.01	1.072	3.518	1.434	0.322	4.882	0.867	4.016
31	0.254	12.87	25.01	1.072	3.519	1.434	0.322	4.882	0.867	4.016
32	0.254	12.86	25.01	1.072	3.517	1.427	0.321	4.862	0.846	4.016

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